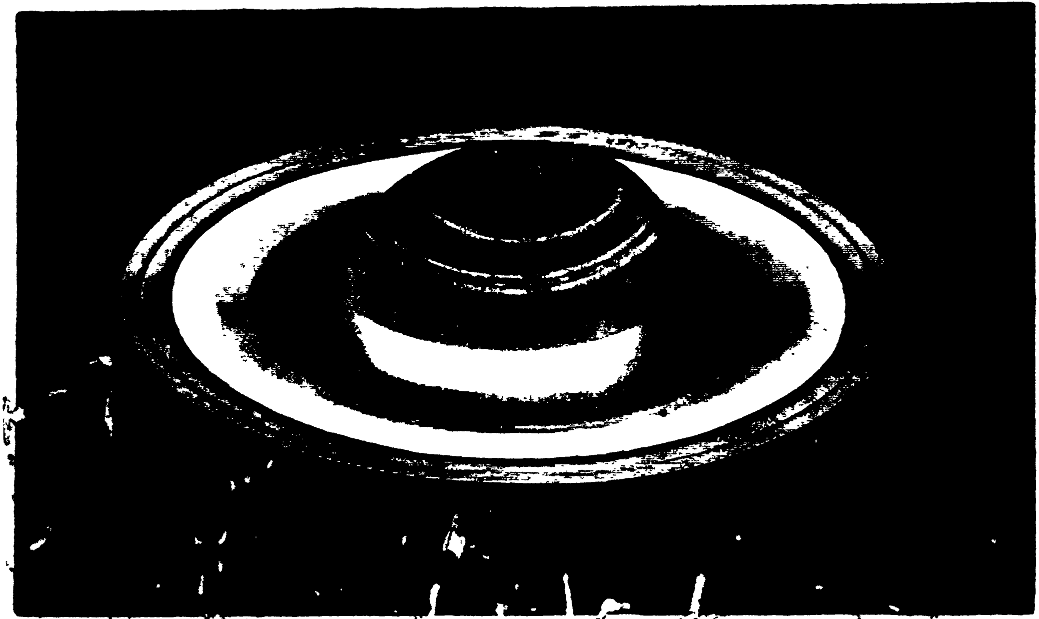

THE PLANET SATURN

LONGMANS' NEW GEOGRAPHICAL READERS

THE P. N

SEVENTH READER

FOR

STANDARD VII.

(THE OCEAN, CURRENTS, TIDES, THE PLANETARY SYSTEM, AND PHASES OF THE MOON)

(Written to meet the requirements of the New Code of 1886 *and in accordance with the Instructions to H.M. Inspectors)*

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APPENDIX.

1. THE OCEANS.

The Earth, as seen from the Moon, would appear as a vast globe of water with two great masses of land rising from it. For while the solid land covers about 52 millions of square miles of the Earth's surface, the waters cover 145 millions. The two great masses of land we call the **Old** and **New World**, and to various parts of the water we give the names of—

(1) The **Atlantic Ocean**, lying between the western shores of Europe and Africa and the east coasts of America.

(2) The **Pacific Ocean**, lying between the west coast of America and the east coast of Asia.

(3) The **Indian Ocean**, lying between the south of Asia and the Antarctic Circle.

(4) The **Arctic Ocean**, lying within the Arctic Circle.

(5) The **Antarctic Ocean**, lying within the Antarctic Circle.

2. DEPTH OF THE OCEAN.

The depth of the ocean is found by sounding. The sounding-line is carried down by a weight which is so contrived that on reaching the bottom the weight becomes detached, leaving a pair of scoops attached to the sounding-line. These scoops pick up a sample of the sea-bed and bring it to the surface. 'The general result,' says Professor Wyville Thomson, 'to which we are led by the careful and systematic deep-sea soundings which have been undertaken of late years is that the depth of the sea is not so great as was at one time supposed, and does not appear to average more than 2,000 fathoms—about equal to the mean height of the elevated table-lands of Asia.'

Average depth: About 2,000 fathoms.

Greatest depths: In the Atlantic the deepest soundings have been taken between the West Indies and Bermuda at a depth of about 4½ miles.

In the **Pacific**, the deepest soundings have been taken off the coast of Japan at a depth of about 5¼ miles.

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3. SALTNESS OF SEA-WATER.

Sea-water is both salt and bitter. In all parts of the ocean, water holds in solution a certain quantity of solid matter of which the greatest part is chloride of sodium (2Na Cl) or salt. Saltness varies very much in different parts, and also at different depths. It varies considerably in the closed seas, where the saltness depends very largely upon the amount of fresh water poured in by rivers and the rate of evaporation from the surface. Where great rivers flow into the ocean, the water is less salt at the surface, because the density of the salt water being greater than that of fresh water, the salt water sinks and the fresh water easily flows over it.

Generally the waters of the **Atlantic are salter than those of the Pacific.**

The proportion of solid matter in the ocean is about 34 parts in 1,000.

The **Red Sea** contains the **saltest water.** This is owing to the great evaporation always going on, and because no fresh water is poured into it by rivers.

The waters of the Red Sea contain 43 parts of solid matter in 1,000 parts. The supply of water is kept up by a current which flows into it from the Indian Ocean. The water of the Baltic Sea contains only 5 parts of solid matter in 1,000 parts. This small amount of saltness in the water is due to the large amount of fresh water poured into this sea by many rivers. The surplus waters are carried off by a current which always flows from the Baltic Sea into the North Sea.

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4. COLOUR AND TEMPERATURE OF SEA-WATER.

Sea-water naturally possesses a pure bluish tint, which is only rendered visible to the eye when the light penetrates through a layer of water of considerable depth. Shallow water has a green colour owing to the amount of suspended matter in the water.

The waters of the ocean far away from land are deep blue. The

North Sea is green, partly from its waters not being clear and partly from the reflection of its sandy bottom mixing with the blue tint of the water.

The colouring of the Red Sea is owing to the presence of vast numbers of very small sea-weeds floating at the surface.

The seas near Greenland are of an olive-green colour, due to the presence of myriads of a small, yellowish jelly-fish.

The colour of the waters of the Yellow Sea is due to a yellowish mud.

The temperature of the surface water varies according to latitude. At considerable distances below the surface the temperature varies but little all over the oceans.

At depths of from 800 to 1,200 fathoms the constant temperature may average about 40° (Fahr.) At depths of 2,000 fathoms and upwards the thermometer usually indicates a minimum temperature of 35°.

In certain restricted areas the temperature falls to a degree or so below the freezing-point of fresh water. Fresh water freezes at a temperature of 32°, but sea-water freezes at a temperature of 27°.

In the Tropics the surface water reaches a temperature of 84°; the water of the Gulf of Mexico 90°, and that of the Red Sea 94°.

5. OCEAN CURRENTS.

Causes.—Ocean currents are produced by several distinct causes, some of which correspond in their nature to the main causes which create and vary the direction of winds.

Under-Currents.—In tropical regions the surface water becomes highly heated, and has a tendency to overflow towards the north and south. In the Frigid Zones the surface water becomes cooler than the water below it; this colder water consequently sinks, owing to its increased density. Hence under-currents of cold water are caused, and these move at great depths towards the tropics.

The direction in which these under-currents flow is greatly modified by the shape of the sea-bed and the configuration of the coast.

Surface Currents.—The surface currents are caused by the heating of the waters at the surface, and by the prevalent winds which set the water in motion.

Kinds of Currents.—Currents, other than tides, may be divided into three classes:—(1) **Constant Currents**, produced by differences in temperature and modified in their courses by winds.

(2) **Periodic Currents**, due to the action of **Land and Sea Breezes** and **Monsoons.**

(3) **Counter Currents**, which flow side by side but in contrary directions to all the great currents.

(4) There is also to be recognised a **constant creep** of cold Polar water towards Equatorial regions, and a general low drift of warm water towards the poles.

6. CURRENTS IN THE ATLANTIC OCEAN.

1. A **Constant Current** flows from the Antarctic regions in a northerly direction to each of the great oceans.

2. The currents from the Antarctic and Indian Oceans join off the south of Africa, and flow in a **north-westerly** direction across the South Atlantic Ocean as the **Equatorial Current of the Atlantic.**

3. Crossing the Atlantic, this current strikes the coast of Brazil and divides into two branches; one runs along the coast of South America under the name of the **Brazil Current.**

4. The northern of these two branches, however, is by far the more important. It flows through the Caribbean Sea into the Gulf of Mexico, and issues from thence as the well-known **Gulf Stream.**

5. An **Arctic Cold Current** flows from the Arctic Ocean through Davis Strait and meets the Gulf Stream off the coast of Newfoundland. The meeting of two moving bodies of cold and warm water causes the fogs for which the **banks** off Newfoundland are so famous.

7. THE GULF STREAM.

The Gulf Stream is a broad belt of warm water which flows out of the Gulf of Mexico through the Straits of Florida, after passing which it takes a north-easterly direction and flows nearly parallel to the coast of North America. In about 40° N. lat. it bends to the east and crosses the Atlantic, widening as it goes, and gradually loses its distinctive character until it becomes split up into several branches.

One part travels to the south, and after skirting the north-west coast of Africa is seized hold of by the North-East Trade Wind and is

swept again into the **Equatorial Current.** Another branch washes the shores of north-western Europe.

Temperature and Velocity.—When issuing from the Straits of Florida the Gulf Stream has a temperature of upwards of 80°, and a velocity of nearly 5 miles an hour. When between the coast of the United States and Bermuda its temperature is still as high as 70°, while that of the water below it and over which it flows is only 35° to 40°. As it crosses the Atlantic it parts with its heat very slowly.

Size.—Between the United States and Bermuda the Gulf Stream is about 70 miles wide and has a depth of about 100 fathoms. When we consider that the average depth of this part of the Atlantic is more than 2,000 fathoms it will be seen that the Gulf Stream is extremely shallow. As it moves onwards it becomes wider and shallower. Its total course is at least 3,000 miles. Its waters are of a deep blue colour.

8. CURRENTS IN THE PACIFIC OCEAN.

The currents of the Pacific Ocean are less definite, and for the most part much less known than those of the Atlantic. They are:—(1) The **Antarctic Drift Current** flows northwards along the west coast of South America, as the **Peruvian** or **Humboldt's Current.** This is a very cold current, and lowers the temperature of the countries along the coast. (2) The Peruvian Current turns west between the equator and 10° S. lat., and then becomes part of the **Pacific Equatorial Current.** This current, under the influence of the trade winds, flows westerly across the Pacific Ocean towards the east coast of Asia. It then splits into three parts, the most important of which is the (3) **Japanese Current,** or the Black Stream. This current brings heat to the shores of Japan and corresponds to the Gulf Stream of the Atlantic Ocean, but it is neither so large nor so warm as the latter.

9. CURRENTS IN THE INDIAN, ARCTIC, AND ANTARCTIC OCEANS.

The **Equatorial Current** of the Indian Ocean also flows to the west. Off Madagascar it splits into two branches, one going round the north and the other round the south of that island. These two branches unite before reaching the Cape, where the current is again divided, one part flowing into the Atlantic Ocean while the other turns to the east and flows back into the Indian Ocean.

Cold Currents flow from the Arctic Ocean into both the Atlantic and Pacific Oceans. That which flows southwards through Davis Strait is the best known. The strength of this current may be judged from the fact that in the summer of 1857 a ship named the 'Fox,' which was enclosed by ice, drifted southwards for a distance of nearly 1,200 geographical miles.

There is a **constant drift** of **cold water** from the Antarctic Ocean to the southern Atlantic, Pacific, and Indian Oceans.

This is the cause of the coldness of the **Peruvian Current**, which chills the western coasts of South America.

10. WINDS.

General Causes.—The chief cause of the winds is the **difference in temperature** of the atmosphere in different places.

The chief **constant winds** of the oceans are due to the difference in temperature of the atmosphere at the equator and at the poles. Where the air is cooler it is denser, and where it is warmer it is lighter. The lighter air rises, the cooler air rushes in to take its place, and thus a **wind is caused.**

Land and Sea Breezes.—A simple illustration of this truth is seen in warm maritime regions, where alternations of **land and sea breezes** correspond with alternations of day and night. In the day-time the land becomes hotter than the water of the sea. The air over the land becomes heated from its contact with the earth. This **hot air rises** and cooler air from over the sea **blows inwards** to the land, thus causing a **sea-breeze.**

At night, exactly the opposite happens. The land parts with its heat during the night much more rapidly than the water does, and its temperature sinks below that of the sea. The air over the sea is consequently hotter than that over the land. The **warm air rises**, being pushed upwards by the greater density of the air lying next to it, and the cooler air from over the land **moves outwards** to take its place. In this way a **land-breeze** is caused.

Direction of Winds.—But differences of temperature are not the only causes which regulate the direction of winds. Inasmuch as every part of the earth makes a complete rotation in the same period of twenty-four hours, it follows that the parts on the equator which traverse the largest circle must move faster than any others. A wind, therefore, which has been set in motion by differences in temperature, and is moving towards the equator, is always moving towards places which are rotating faster than the places it is leaving. When a wind is blowing from the equator the reverse is the case.

11. THE TRADE WINDS.

Within the Torrid Zone the heat of the sun is so great that the air becomes highly heated, and consequently large volumes of air are constantly rising, while to fill its place other volumes are constantly moving from the colder regions of the north and south.

This alone would cause constant winds at the earth's surface from the north and south.

But it has already been shown that winds coming from the north and south and moving towards the equator are leaving parts of the earth which revolve much more slowly than the earth does at the equator. Hence these winds have a tendency to lag behind, and, as the earth turns towards the east, the winds from the north and south become north-easterly winds in the Northern Hemisphere, and south-easterly winds in the Southern Hemisphere.

These winds are known as the **Trade-Winds**, and they blow steadily all the year round.

12. WINDS OF THE ATLANTIC OCEAN.

1. **The Trade-Winds.**—The North-East Trade-Wind blows constantly between 9° and 27° N. lat., and the South-East Trade-Wind between 3° N. and 25° S. lat. The south-east trades having a greater width of sea to blow over are fresher and stronger than the north-east trades.

2. **The Doldrums.**—Between the two regions of trade-winds lies the dreaded girdle or zone of the equatorial calms, the well-known doldrums, where long calms alternate with dreadful storms.

3. **The Horse Latitudes.**—Outside the region of the trade-winds, for

10° or 12° on each side, is a region called the **horse latitudes**, where sailors find an alternation of wind and calm.

4. In the temperate regions of the North Atlantic warm winds from the **south-west** prevail during a great part of the year.

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13. WINDS OF THE PACIFIC AND INDIAN OCEANS.

1. The **North-East Trade-Winds** and the **South-East Trade-Winds** blow constantly on opposite sides of the equator. The Trade-Winds of the Pacific, however, are not so strong, neither do they blow so constantly and steadily as those of the Atlantic Ocean. This is partly due to the presence of a vast number of islands, among which the winds become to a certain extent broken up.

2. The chief winds of the Indian Ocean are:—(1) the **North-Easterly Monsoon** in the cool season. (2) The **South-Westerly Monsoon** in the hot season. It is from the latter monsoon that India derives its rainfall.

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14. WAVES.

If you blow upon a basin of water, the movement of the air is at once imparted to the water, and the surface is thrown into a succession of ripples.

In the same way each puff of wind at sea catches hold of the water and heaps it up a little into a wave with its steep side away from the wind; then the crest falls and the water sinks down into a trough as deep below the mean surface as the wave was above it. In this way the motion of the wave may be propagated over a broad expanse of water. If the wave meets a cork in its course, the cork is simply rocked up and down and is not propelled forward.

This is because the motion of the water is merely that of undulation, and the water itself is not carried forward.

Height of Waves.—In shallow water, such as that of the North Sea, the height of the waves rarely exceeds eight to ten feet. In the open ocean the height of the waves rarely exceeds forty feet.

Pressure of Waves.—On the western shores of Great Britain the waves which roll in from the Atlantic in summer exert a pressure of about 600 lbs. per square foot. In winter the waves on the same coast sometimes exert a pressure of as much as three to four tons on the square foot.

15. THE ATLANTIC OCEAN. (I.)

The Atlantic Ocean is a long irregular valley filled with water, and it has a most uneven coast-line.

Position and Size.—The Atlantic Ocean extends from the Arctic Circle to the Antarctic Circle. On its eastern side it washes the shores of Europe and Africa. On its western side it washes the shores of North America and South America.

Length.—Nearly 10,000 miles.

Breadth.—Its width varies from 800 miles between Greenland and Norway to 1,500 miles between Brazil and Sierra Leone, whilst at its widest part, between Florida and the coast of Africa, it measures 3,600 miles.

Area.—About 38,400,000 square miles.

Principal Parts.—**Eastern**: The Mediterranean Sea between Europe and Africa; the Black Sea between Europe and Asia; the Baltic Sea, the North Sea, the Irish Sea, the English Channel, the Bay of Biscay, and the Gulf of Guinea.

Western: Hudson Bay; Gulf of St. Lawrence; Gulf of Mexico, Caribbean Sea.

16. THE ATLANTIC OCEAN. (II.)

Shape of Ocean-bed.—The shape of the ocean-bed has been found by sounding. Many expeditions have been sent out to study the oceans, and much has been learnt from the soundings necessary for laying the telegraph cables.

From the west coast of Europe a submarine plain forms the floor of the Atlantic for several hundreds of miles. From this floor rises the mass of land known as the British Isles. These are separated from the mainland of Europe by two bodies of water, the North Sea and the English Channel, in both of which the water is so shallow that a depth of 300 feet is rarely met with.

At a distance of about 200 miles west of Ireland there is a rapid descent to a depth of about 2,000 fathoms, from whence the ocean floor stretches out as a **vast undulating plain** until it reaches to within about 300 miles from the coast of Newfoundland. It then gradually rises to the shores of America. This great plain has a breadth of about 1,000 miles and an **average depth of about 10,000 feet,** *i.e.* about two miles. Across this plain the telegraph cables have been laid.

It is covered with a deposit of fine greyish mud called **ooze.** This consists of myriads of small bodies that are the skeletons of animals of a very simple kind. They exist in myriads a few fathoms below the surface. Here they live and die, and their shells fall in an unceasing shower on the bed of the ocean. At greater depths than 2,000 fathoms the place of the ooze is taken by a **red clay.**

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17. SEAS OF THE ATLANTIC OCEAN.

MEDITERRANEAN SEA.—Size and Position: The Mediterranean lies between the south of Europe and the north of Africa. It covers nearly a million of square miles. It opens into the Black Sea by the Dardanelles, Sea of Marmora, and Bosporus. The waters of the Black Sea are **brackish,** owing to the immense quantity of fresh water poured into it by the rivers.

The bed of the Mediterranean is divided into two parts by a ridge, which causes shallow water between the south of Italy and Africa.

Temperature, &c.—The temperature of the water of the Mediterranean is several degrees higher than that of the Atlantic Ocean outside the Strait of Gibraltar.

Currents.—A current sets steadily from the Black Sea into the Mediterranean, and so carries off the surplus waters poured into it by the rivers.

Another current flows from the Atlantic Ocean into the Mediterranean, and so makes up for the deficiency caused by evaporation.

Islands.—Balearic Islands, Corsica, Sardinia, Sicily Maltese, Islands, Ionian Islands, islands of the Grecian Archipelago, Candia, and Cyprus.

Rivers.—The Don, into the Sea of Azov; the Dnieper, Dniester, and Danube, into the Black Sea; the Maritza, Po, Adige, Rhone, Ebro, and Nile, into the Mediterranean.

18. SEAS AND ISLANDS OF THE ATLANTIC OCEAN.

THE NORTH SEA is bounded by Norway and Denmark on the East, by Germany, Holland, and Belgium on the South, and by the British Isles on the West.

Tides.—The tides in the North Sea are very complicated. In the southern corner two tideways unite. Hence in the Estuary of the Thames the tides rise high and regularly.

Rivers.—Elbe, Weser, Rhine, Scheldt, Thames.

THE BALTIC SEA is long, tortuous, and narrow. It is entered by very narrow straits, is very shallow, and receives a large drainage. Hence its waters are brackish.

Area.—About a quarter of a million of square miles.

Rivers.—Oder, Vistula, Dwina, Neva.

Current.—A current flows steadily from the Baltic Sea into the North Sea.

THE CARIBBEAN SEA and **Gulf of Mexico** lie between the mainland of the American continent and the West Indian Islands.

Area.—Together they cover about two millions of square miles. The Caribbean Sea is very much the larger. Its depth is very great and its waters very hot.

River.—The Mississippi flows into the Gulf of Mexico.

Other rivers flowing into the Atlantic.—**European**: Seine, Loire, Garonne, Douro, Tagus.

African: Niger, Congo, Orange River.

American: St. Lawrence, Hudson, Orinoco, Amazon, La Plata.

The most important group of islands in the Atlantic is that of the **British Islands.**

The **West Indian Islands** rank next to the British Isles in importance. They consist of the large islands of Cuba, Hayti or San Domingo, Jamaica, Trinidad, and hundreds of smaller ones.

There are also in the **North Atlantic**, the Faroe Islands, Iceland, Newfoundland, Anticosti, Cape Breton Island, Prince Edward Island, Madeira, Cape Verd, the Azores, the Bahamas, Bermuda. In the **South Atlantic**: Ascension Island, St. Helena, the Falkland Islands, Tierra del Fuego.

19. CORAL AND CORAL ISLANDS.

Fringing Reefs.—In tropical seas, and particularly in the Pacific Ocean, there are many islands skirted by low banks of coral rocks. At high tide these rocks are mostly under water and their position is marked by a white line of heavy breakers. At low water the rocks appear just above the surface. Such coral rocks are called **Fringing Reefs.** Some islands are completely surrounded by fringing reefs, while others are only fringed at certain points.

Barrier Reefs.—In other cases the reefs are at some distance, perhaps many miles from land, so as to form a barrier to the coast. Such reefs are called **Barrier Reefs.** Between the coast and the reef there is smooth water, entrance to which is obtained through gaps in the reefs.

The **greatest barrier-reef** is the **Great Barrier Reef,** which skirts the north-east coast of Australia for a distance of 1,200 miles, at an average distance of from 20 to 30 miles from the coast. The channel between this reef and the coast has a depth of about 25 fathoms, while outside the depth of the sea suddenly increases to many hundreds of fathoms.

Atolls.—But there are islands which are completely composed of coral. These islands rise from the sea usually as a low strip of land, more or less ring-shaped. Inside this rim of rocks there is a shallow lake or **lagoon** of clear green water. The outer rim of coral land is generally tufted with cocoa-nut palms. Entrance to the lagoon is obtained through gaps in the reefs. These circular shaped coral-islands are called **Atolls,** and are very abundant in the Pacific and Indian Oceans.

Range of Coral Animals.—Corals of some kinds live in all seas, but the **particular** kinds which grow in masses, and thus form reefs and islands, are found only in the warmer parts of the world. Reef-forming coral animals are only found in waters of which the mean temperature for the month, even in the coldest season, never falls below 68°. Such a belt of warm water never extends beyond 32° from the equator.

20. THE PACIFIC OCEAN.

Position and Size.—The Pacific Ocean alone covers more than half the surface of the globe. Its area is about 90 millions of square miles.

It lies between the shores of America on the east and those of Asia and Australia on the west.

Length.—From the Arctic Circle to the Antarctic Circle its length is about 10,000 miles.

Width.—At its northern extremity its width is not more than about 40 miles. Between California and the coast of China its breadth is about 8,500 miles.

The Pacific has but few large inland seas opening from it, nor does it receive the drainage of a large number of important streams. The depth of the Pacific is in parts very great.

Rivers.—**American**: The Fraser, Colorado, and Columbia. **Asiatic**: The Amur, Hoang-Ho, Yang-tse-Kiang, Canton River, and Mekong.

21. ISLANDS OF THE PACIFIC. (I.)

The Pacific contains a vast number of islands, most of which are of very small size. The term **Polynesia** is applied to embrace all the islands of the Pacific. The chief groups of islands are:—

(1) **New Zealand.**—This group lies to the south-east of Australia, and is surrounded on all sides by the Pacific Ocean. It consists of two large islands, the **North Island** and the **South Island**, and some small ones. The group comprises an area of about 106,000 square miles. The two large islands are separated by Cook Strait.

These islands form one of the colonies of the British Empire.

(2) **The smaller islands of Polynesia.**—Most of these lie to the south of the equator, within the southern part of the Torrid Zone. The chief groups are:—The Sandwich Islands, Caroline Islands, and the Tonga or Ladrone Islands, all lying in north latitude.

The Friendly Islands, Samoa Islands, Cook's Islands, Society Islands, Low Archipelago, and the Marquesas Islands, all lying in south latitude.

Some of these islands are mountainous and of **volcanic formation**, as the Sandwich Islands. The rest are chiefly coral islands.

The Sandwich Islands are very mountainous. The principal summits in the island of Hawaii (or Owhyhee), the largest of the group, attain a height of about 14,000 feet. This whole island is a mass of volcanic matter, and contains an active volcano, Kilauea, the eruptions of which are of tremendous power.

The Society Islands are of equally varied surface. The highest point of Tahiti (or Otaheite), the largest of the group, is 12,000 feet above the sea.

Climate.—The climate of the islands of Polynesia is warm, but is tempered by the influence of the surrounding ocean.

Productions.—The vegetation is rich and abundant. The chief article of food of the natives is the fruit of the bread-fruit tree. Nearly all European plants and vegetables flourish.

22. ISLANDS OF THE PACIFIC. (II.)

The third group of islands consists of New Guinea, the Japanese Islands, the Philippine Islands, Borneo, Celebes, Molucca, New Britain, New Ireland, the Solomon Islands, New Caledonia, the Fiji Islands, and many others.

New Guinea or **Papua** is of immense extent. The northern coasts are mountainous; the southern coasts, opposite Torres Strait, are low. Little is known of the interior of the island, but various places round the coast are visited for trading purposes.

The beautiful 'bird of Paradise' is a native of this island.

New Caledonia belongs to France, and is used as a place of transport for political offenders.

The Fiji Islands.—This group comprises two large islands with a great number of small ones. The largest island is 85 miles long by 40 broad. Vegetation is remarkably luxuriant. **Cotton** grows well, and is the chief export. Population, about 150,000. The Fiji Islands form part of the British Empire.

23. THE INDIAN OCEAN.

Position and Size.—The Indian Ocean is bounded by Asia, Africa, Australia, and the Antarctic Circle.

Its area is about 28 millions of square miles.

ISLANDS.—**Ceylon** is a large island lying to the south of India, and forms part of our Indian Empire. Its chief town is Colombo.

Sumatra has an area of about 150,000 square miles. It contains several native states and some Dutch settlements.

Java is the most important and populous island of the Malay Archipelago. Chief town, Batavia. It belongs to the Dutch.

Madagascar has an area of about 228,000 square miles, and has a population of about 3 millions.

Mauritius belongs to the British Empire. It exports sugar.

Rivers flowing into the Indian Ocean.—Irrawady, Brahmaputra, Ganges, Godavery, Krishna, Tapti, Nerbudda, Indus, and Euphrates.

24. THE ARCTIC OCEAN.

Position and Size.—The Arctic Ocean is bounded by the northern coasts of Europe, Asia, and America, and by the Arctic Circle. It includes an area of about 3 millions of square miles of water.

It is connected with the Atlantic Ocean by a wide strait between Greenland and Norway, and with the Pacific Ocean by Behring Strait.

It is for a large part of the year completely choked with ice, but there is water communication in summer connecting the Atlantic and the Pacific.

Islands.—**Spitzbergen** and **Nova Zembla**, to the north of Asia; **Greenland** and an **archipelago**, to the north of America.

All the islands of the Arctic Ocean exhibit a naked and dreary surface. Steep rocks rise from the coast, and the surface of the interior is buried under ice and snow for ten months of the year.

Rivers.—**Asiatic**: Obi, Yenesei, Lena.
American: Mackenzie, Great Fish River.
European: Dwina, Petchora.

Length of Day.—At the poles the sun is above the horizon for six months continuously, and below it for an equal period. But at the poles the sun never rises higher than 23½° above the horizon, and the extreme obliquity of its rays prevents them from having much heating power.

25. THE ANTARCTIC OCEAN.

The Antarctic Ocean lies within the Antarctic Circle, and is a continuation of the Atlantic, Pacific, and Indian Oceans to the south.

It is much colder than the Arctic Ocean, and the ice extends to a distance of about 600 miles nearer to the equator than the ice of the northern seas. Nearly all that we know of the Antarctic Ocean was discovered by Sir James Ross. He penetrated the ice for some distance, and reached land upon which an active volcano was visible. This he found to be about 12,000 feet high, and gave it the name of **Mount Erebus**. An extinct volcano to the eastward was named **Mount Terror**, and was found to be nearly 11,000 feet high.

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26. OCEAN ROUTES.

(1) **Atlantic Ocean.**—That part of the Atlantic which lies between the British Islands and North America is the most frequented. From **Liverpool** round the **South of Ireland** and across the Atlantic to New York takes from 8 to 10 days. Very fast ships have steamed over this route in less than 7 days. From **Hamburg**, through the English Channel, to New York takes from 12 to 13 days.

From **Liverpool** to New Orleans, about 25 days.

From **Liverpool** to Pará, about 18 days.

From **Southampton** to the West Indies, about 15 days.

From **Plymouth** to Cape Town, about 30 days.

From **London** to **Australia** by the Cape of Good Hope, about 50 days.

From **Liverpool** to Monte Video, about 26 days.

From **London** to India (Bombay), *viâ* the Suez Canal, about 26 days.

From **London** to Hong Kong, *viâ* the Suez Canal, about 40 days.

From **Havre** to Colon, about 30 days.

From **Australia** (Sydney) to San Francisco, *viâ* New Zealand and the Sandwich Islands, about 28 days.

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27. THE SOLAR SYSTEM.

By the expression the **Solar System** we are to understand the group of celestial bodies which consists of the **Sun** himself, the **Planets** and their satellites, and the **Comets**. To these should perhaps be added a vast host of very small bodies, which when they come into our atmosphere produce the well-known phenomena of shooting-stars. All the bodies we have mentioned form one isolated group in the universe.

The most prominent member of the group is the **Sun**, which is far larger than all the others, and also differs from them in this important respect, that whereas the sun is intensely hot, the planets are all cool bodies and derive their light from the Sun. Further, the Sun shines by its own light. It is the centre of the Solar System, and the planets revolve around it.

On a clear night the heaven is seen to be bespangled with a vast multitude of minute points of light. Astronomers are in the habit of calling these objects the **fixed stars**, because they maintain their relative position unchanged from year to year.

But there are other bodies which are constantly changing their position. These bodies are called **Planets**. The **Earth** is one of these; and of the others five only can be seen easily with the unaided eye.

28. THE SUN.

The **Sun** is a hot body. It is a star, but compared with others of the fixed stars the Sun is a small body.

Dimensions of the Sun.—The Sun, though really a globe, appears to the unaided eye in the form of a circular disc.

The mean distance of the Sun from the Earth is about 91½ millions of miles. The Earth is about 3 millions of miles nearer to the Sun in our winter than in summer.

The **Diameter** of the Sun is about 860,000 miles; that is, about 110 times the diameter of the Earth.

The **Volume** of the Sun is about 1,330,000 times that of the Earth.

Sun-spots.—When the Sun is observed through a telescope a remarkable phenomenon is often noticed. The brilliant surface of the Sun is often marked over with black spots. The central portion of the spot is intensely dark, and is surrounded by a margin, which, though much darker than the general surface of the Sun, is not nearly so dark as the centre of the spot. Some of these spots are said to be many thousands of miles in diameter.

From careful observations of these spots, astronomers have come to the conclusion that the Sun rotates in much the same way that the Earth does, only the Sun takes about twenty-five of our days to make one revolution.

Gravitation.—The power which keeps the planets in their places as they revolve around the Sun, and the moons in their places as they revolve around the planets, is the force of gravity.

29. THE PLANETS.

The **Planets** are cool bodies travelling round a hot one, the Sun. The names of the planets, arranged according to their distance from the Sun, are as follows:—**Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune.** Of these, Mercury, Venus, Mars, Jupiter, and Saturn are easily seen by the unaided eye.

Mercury is the nearest to the Sun. Its diameter is somewhat less than half the diameter of the Earth.

Venus is about the same size as the Earth, but it has no moon.

Mars has a diameter only about half that of the Earth. It has two very small moons.

Next in order of distance from the Sun comes the vast group of minor planets called **Asteroids.** Of these nearly 200 have already been discovered. The diameters of most of them are probably only a few miles.

Jupiter is the largest of the planets. Its diameter is more than ten times as great as the diameter of the Earth. The time occupied by Jupiter in completing one revolution about the Sun is about twelve years. It has four moons.

Saturn is in some respects the most remarkable object in the solar system. In addition to a retinue of no less than eight moons, Saturn is attended by a ring, or rather a series of rings, which is probably without a parallel in the solar system.

Uranus has four moons.

Neptune has one moon.

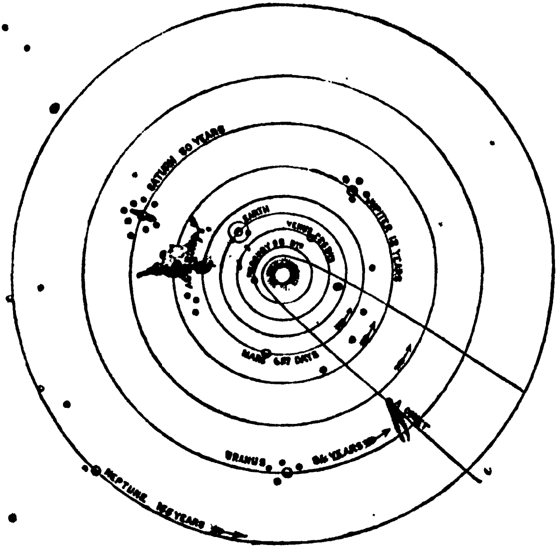
The path of a planet round the Sun is an ellipse, in one focus of which the centre of the Sun is situated.

The mean distance of the Earth from the Sun is about 91½ millions of miles.

The distance of Neptune from the Sun is about 2,800 millions of miles.

Comets.—Besides the planets, there are certain other bodies belonging to the solar system which are sometimes seen moving among the constellations. These bodies are called **Comets.** A comet usually consists of a more or less brilliant point or nucleus, surrounded with a nebulosity which is often extended in one direction so as to form a tail. The orbit of a comet differs widely from that of a planet, and is such that at one time the comet is very near the Sun, and at other times an immense distance away from it.

Shooting-stars are small bodies that form part of the solar system. They sometimes fall down upon the earth, and are the bodies we call **Meteorites.**



30. THE MOON.

Just as the Earth and the other planets revolve in their orbits round the Sun, so does the Moon revolve in her orbit round the Earth.

Being a much smaller body than the Earth, the Moon is held in place by the attraction of the Earth.

The Moon shines by means of the light thrown upon it by the Sun, and which is reflected towards the Earth.

Shape: The Moon is a sphere.

Diameter: 2,159 miles.

Volume: About one fiftieth that of the Earth.

Mass: The Earth's mass exceeds that of the Moon 81½ times.

Distance from the Earth: About 238,000 miles.

Time of Rotation: 27 days 7 hrs. 43 mins.

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31. PHASES OF THE MOON.

The Sun always presents to us a complete circular disc. The Moon, on the contrary, only shows us a complete circular disc for a few hours in each revolution. In the period of 29 or 30 days during which it completes the circuit of the heavens it presents to us every possible gradation between a circular disc perfectly illuminated and perfectly dark.

Let us select some evening in which, just after the Sun has set, the Moon appears low down in the west. The Moon then appears to us in the form of a **narrow crescent**. This we call the **New Moon**. From day to day the crescent enlarges and it sets later, till on the 7th day it appears like a **semicircle** and is visible during a great part of the night. This we call the **First Quarter**. For the next seven days the luminous portion continues to increase, and the Moon is said to be **gibbous**, until on the 14th or 15th day the disc of the moon is entirely luminous. This we call the **Full Moon**. On the following day the western edge of the moon is seen to be somewhat less sharply defined: gradually this part becomes more and more obscured, until on the 22nd day the moon is again a **semicircle**. This we call the **Last Quarter**. About the 28th day the Moon has drawn very near to a position between the Earth and the Sun, after which it becomes invisible for a few days, again to reappear in the form of a narrow crescent, and to repeat the cycle already described.

During the entire revolution of the Moon, the illuminated portion is always turned towards the Sun, and the dark part is turned away from the Sun. Hence it follows that we always see the same face of the Moon.

The Moon's Surface.—The surface of the Moon is very rugged and irregular, and, while there are some regions which appear comparatively level, there are others where mountain-ranges and chasms give an appearance of rugged grandeur to which, perhaps, we have no parallel on the face of the Earth. But the most characteristic objects on the surface of the Moon are what appear to be craters of volcanoes, which, though once active, are now nearly, if not quite, extinct. There are some hundreds of these objects on the surface of the Moon which is turned towards us, and many of them are of truly colossal dimensions.

32. TIDES.

Tides are caused by the mutual attraction of the Earth and the Moon, and in a less degree by the attraction of the Sun.

When the Moon is directly over the ocean it draws the waters into a long heap, stretching north and south, and rising to a height of about five feet or a little more in places, the summit of the bank being almost under the Moon, thus causing high-water, or high-tide as it is called.

Two Tides a Day.—As the Moon is on the meridian of any given point on the Earth's surface only once in twenty-four hours, this explanation would only account for one tide in a day. But when the Moon is causing a tide upon the side of the Earth nearest to it, there is a corresponding heaping up of the waters on the side of the Earth opposite to it. This is due to the fact that the attraction of the Moon has a greater power in drawing the solid Earth slightly towards itself than it has in drawing the waters on the farther side of the Earth. Hence as the Earth is pulled towards the Moon the waters on the farther side run into a heap, and thus a second tide is caused.

Thus there are two tides a day all over the world, for, as the Earth turns on its axis, every place upon its surface must come directly under the influence of the Moon at some time during the day, and must also be on the side away from the Moon at another time in the day.

Tidal Wave.—This heaping-up of the waters forms a long tidal wave. As this wave approaches an indented coast-line, the progress of the wave is stopped, and the water, being confined into narrower channels, rushes up the estuaries and bays, seeking an outlet. Hence in such places the tide rises higher than in the open sea.

The tide rises steadily for six hours, during which time it is to flow, until high-tide is reached.

It then falls or ebbs for six hours, until low-tide or low-wate reached.

Both of these movements take place twice in twenty-four hou

The in-coming tide is called the flood, the out-going tide is the

Difference in Time.—Between the time of one high tide and next following it, the Moon has moved some distance in her orbit; thus a high tide is on an average about 24 minutes later than the which preceded it.

33. SPRING AND NEAP TIDES.

Spring Tides.—At New and Full Moon the Moon and Sun ar such a position towards the Earth that they exert their influe together in drawing up the waters. This causes a higher rising the flood, followed by a lower ebb. These are the highest kind tides, and are called **Spring Tides.**

Neap Tides.—At Half-Moon, or when the Moon is in her first last quarters, the influence of the Sun is exerted at right angle that of the Moon. Hence the flood does not rise so high, nor does ebb sink so low. These tides are called **Neap (nipped) Tides.**

As the Moon takes about 28 days to complete her revolution ro the Earth, it follows that Spring and Neap Tides each occur twic month.

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V GEOGRAPHICAL READER.

STANDARD VII.

1. THE SEA.

THE sea, the sea, the open sea,
The blue, the fresh, the ever free:
Without a mark, without a bound,
It runneth the earth's wide regions round.

It plays with the clouds, it mocks the skies,
Or like a cradled creature lies.
I'm on the sea, I'm on the sea,
I am where I would ever be.
With the blue above and the blue below,
And silence wheresoe'er I go.
If a storm should come and awake the deep,
What matter? I shall ride and sleep.

I love, O how I love to ride
On the fierce, foaming, bursting tide,
When every mad wave drowns the moon,
And whistles aloft his tempest tune;
And tells how goeth the world below,
And why the south-west wind doth blow.
I never was on the dull, tame shore,
But I loved the great sea more and more,
And backwards flew to her billowy breast
Like a bird that seeketh its mother's nest—
And a mother she was and is to me,
For I was born on the open sea

The waves were white, and red the morn,
In the noisy hour when I was born;
The whale it whistled, the porpoise rolled,
And the dolphins bared their backs of gold;
And never was heard such an outcry wild
As welcomed to life the ocean child.
I have lived since then in calm and strife
Full fifty summers a rover's life,

With wealth to spend and a power to range,
But never have sought or sighed for change.
And death, whenever he comes to me,
Shall come on the wild, unbounded sea.

BARRY CORNWALL.

ro'ver: a wanderer.
dol'-phin: an animal of the whale kind, about eight to ten feet long.
por'-poise: also of the whale kind, from four to six feet long; caught for its skin, flesh, and oil.

2. THE OCEAN: INTRODUCTORY.

If an observer could be carried to the moon and from there obtain a view of the earth, he would at once be struck with the fact that the earth ought to be spoken of as a globe of water. Even if he looked at the northern hemisphere the land would form the smaller part of the vast expanse which met his view; whereas if he could be in such a position as to see the southern hemisphere, his eye would rest upon a wide stretch of water with land only appearing as specks upon its surface. This mighty mass of water we call the *Ocean*, and though we give particular names to various parts of it, such as the Atlantic, Pacific, Indian, Arctic, and Antarctic Oceans, there is in reality but one ocean, whose waters encircle the globe.

To the Englishman the Atlantic Ocean is by far the most interesting part of this great mass of waters. He cannot live more than a day's journey from the sound of its waves, and its nearness to the shores of his native country is one of the chief causes of that country's greatness.

What an object of awe and mystery must the ocean have been to the men who lived in England two thousand years ago, as they watched its billows break in fury upon the storm-beaten shores! We can imagine how the fisherman in his rude boat of wickerwork and skins would fearfully paddle as far as the mouth of the river, and then, as the wind freshened, hurry home for fear the waves should overturn his frail cockle-shell of a boat. Across the sea came the Romans in their galleys, with the long oars flashing in the sunlight and gay and bright with waving banners and armed men. From over the North Sea came the rude Saxon pirates, at first merely to plunder the coasts, but in the end to take the country for themselves and so found a nation of Englishmen. After a time came the 'hardy Norseman' of whose fame we still sing, and whom we are proud to place among the men who helped to make England. And, lastly, came the Normans or Northmen, descendants of the same race as the Norsemen, who, though for many years they kept aloof, gradually adopted the same language as the English whom they at first despised, and became merged into the nation which they conquered.

For several hundreds of years after this the English steadily grew in power and wealth, and above all in their love for the sea. They had a sufficient number of ships to be able at any time to transport an army to the coasts of France, and over and over again they invaded its shores. But we never hear of the French or any other nation attempting to land an army in England until the days of the Spanish Armada.

About a hundred years before the latter event came the astounding news that a brave captain named Christopher Colon, or, as we now call him, Columbus, had sailed over the Atlantic, far, far to the West, and discovered a New World! What wonderful possibilities were opened up to the men of that time. The whole of civilised Europe was fairly astir with the news. Men dreamed of fabulous wealth, of gold and silver and precious stones to be had for the mere picking up in lands beyond the sea. The Spaniards sent fleet after fleet to seize the lands for their king. Nor were the English behindhand. Private individuals fitted out expedition after expedition to explore new lands and search for gold. The names of such men as Drake, Raleigh, Gilbert, Frobisher will ever live in our annals as leading the van in the progress of maritime discovery. The torch of discovery set alight in those days has burned brightly ever since, and these heroes of the sea have been followed by a long line of brave seamen who have carried the English flag into every harbour of the world, and have done more than the men of any other nation to solve the mystery that still hangs about the way to the Pole.

And the heroism of these bold sailors strikes us more forcibly when we think of the kind of ships they had. Columbus in the 'Santa Maria,' of about 100 tons; Sir Humphrey Gilbert in the 'Squirrel,' of ten tons; Drake, who made his famous voyage round the world in the 'Pelican,' of 100 tons—these are only samples of the craft in which these men faced the storms of the Atlantic. How their bravery stands out when we compare these ships with the 'greyhounds' of the Atlantic of modern days—those floating hotels of the sea which can carry a thousand passengers from the Old World to the New in less than seven days!

Upon the Atlantic Englishmen have wrought their most famous deeds. Upon its waters and by the aid of its storms they drove from their shores the mighty Spanish Armada, and at Trafalgar they broke the power of the mightiest conqueror of modern times, and again saved their native land from the dangers of invasion. And across its surface have sailed millions of Englishmen, who have founded nations and carried English laws and liberty to the uttermost parts of the earth.

Drake: one of Queen Elizabeth's famous captains, who was the first Englishman to sail into the Pacific and make the voyage round the world.

Frobisher: explored the coasts of North America; he fought in the battles with the Spanish Armada, and for the part he took in driving back the Spaniards was knighted by Elizabeth.

Gilbert, Sir Humphrey: another of Elizabeth's captains, who was drowned on his return home after exploring the coasts of North America.

Raleigh: a famous captain and courtier of Elizabeth's reign; was executed by James I. in 1618.

Spanish Armada: a mighty armament sent in 1588 to attempt the conquest of England; more than two-thirds of the ships were destroyed by the English or wrecked.

Trafalgar: a cape in the south of Spain, near which Nelson completely broke the naval power of the French, 1805.

3. THE OCEAN: SALTNESS AND TEMPERATURE.

Water, water everywhere,
Nor any drop to drink.

So sang the Ancient Mariner, and since Coleridge wrote the wonderful poem from which these lines are taken how many a shipwrecked mariner has had the same fatal experience! Vast as the ocean is, its waters are not fit to drink. Sea water is both salt and bitter, and holds in solution a certain quantity of solid matter of which the greatest part is chloride of sodium ($2NaCl$) or common salt.

The saltness of sea water varies very much in different parts and also at different depths. In narrow or enclosed seas in hot climates the water is very salt. This is especially seen in the Red Sea, where the temperature is very high and the evaporation is very rapid. When evaporation takes place, only the water ascends as vapour and the solid matters are left behind. In this sea the evaporation is so great that currents of water are all the while flowing into it to make up for the loss thus sustained. Hence we see that, as salt water is constantly being poured into this sea and fresh water is taken out, the salt accumulates, and so the water becomes salter than that of the surrounding ocean. On the other hand, the saltest water sinks to the bottom, and there is no doubt that a current of very salt water flows along the bottom of the Red Sea into the Indian Ocean.

The waters of other inland seas contain less salt, and some are even brackish. This is the case when a shallow sea receives the waters of numerous large rivers. Thus, while the waters of the Red Sea contain 48 parts of solid matter in 1,000 parts, those of the Baltic Sea contain only 5 parts of solid matter in 1,000 parts. Such a large quantity of fresh water is poured by the rivers into the Baltic Sea, and evaporation goes on so slowly owing to the comparative coolness of the climate, that there is a constant current which flows out of the Baltic into the North Sea to carry off the surplus waters.

Again, owing to the quantity of solid matter in it, salt water is denser than fresh water. In places where large quantities of fresh water are discharged into the salt-waters of the ocean the fresh water, owing to its less density, flows over the salt water. The largest river which empties itself into the Atlantic Ocean is the Amazon, and for many miles from its mouth the fresh water of the river forms a current, flowing over the salter water beneath; so that the sailor has but to drop his bucket overboard to bring up fresh water even when many miles from land.

Generally speaking, the proportion of solid matters in the waters of the ocean is about 34 parts in 1,000, but the waters of the Atlantic are salter than those of the Pacific. The waters of the northern seas are not nearly so salt as those of mid-Atlantic. This is probably owing to the large quantity of fresh water which falls as rain, and which, being less dense than the salt water upon which it falls, floats upon the surface, and also to the presence of ice in large quantities in the Polar Seas. For when water freezes the salt falls, and the vast icebergs and icefields which are brought by currents and winds from Polar regions to the North Atlantic are converted into fresh water when they melt, and so help to diminish the saltness of the waters in which they float. The under-currents which flow from the Polar regions towards the Tropics carry with them water which is salter than that at the surface, and this may help to account for the vast body of very salt water which exists in the Atlantic Ocean in the extent of almost still water lying between the Gulf Stream and the Equatorial Current.

Temperature.—The temperature of the surface waters of the ocean varies according to latitude as does the temperature of the air; but the temperature of the water never presents the same striking contrasts as the temperature of the air. Water being so much denser than air, the rays of heat do not penetrate it so easily. Thus while in temperate regions the difference in the temperature of air between day and night may be as much as 30°, the water retains nearly the same amount of heat by night as by day. Further, water parts with its heat much more slowly than air does, and so there is not so much difference between its temperature in summer and winter.

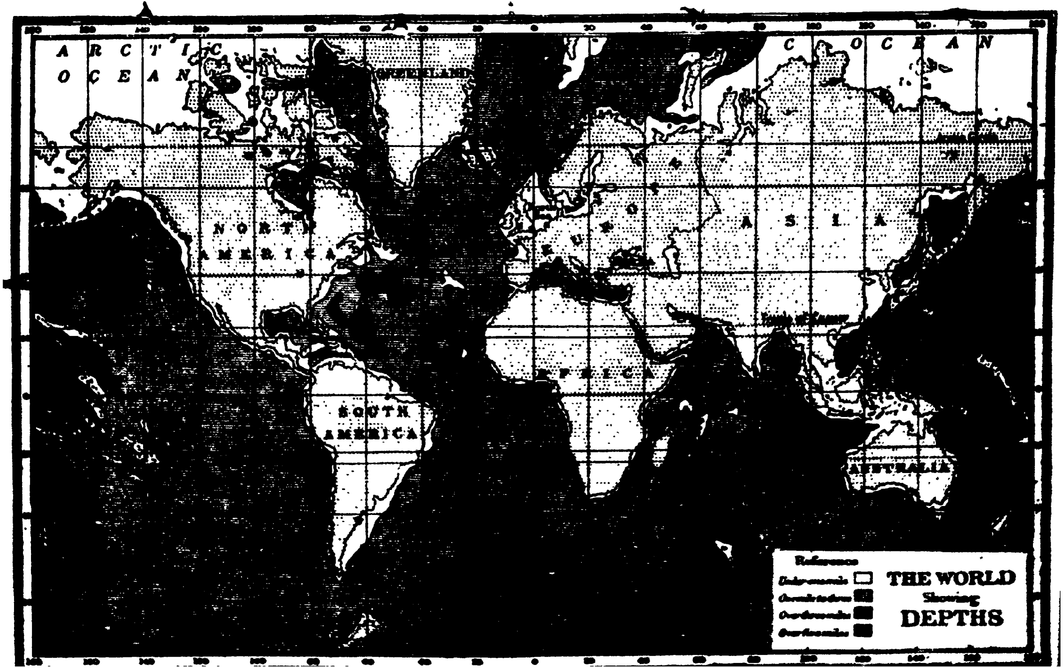
It has been found by recent discoveries that at considerable distances below the surface the temperature varies but little all over the oceans. At depths of from 800 to 1,200 fathoms, the constant temperature may average about 40° (Fahr.) At depths of 2,000 fathoms and upwards the thermometer usually indicates a minimum temperature of 35°. While in certain restricted areas and at very great depths the temperature falls to a degree or so below the freezing-point of fresh water. We say of fresh water because, while fresh water freezes at a temperature of 32° (Fahr.), sea water does not freeze until it is five degrees colder; that is to say, at a temperature of about 27°.

But in the tropics the surface water becomes highly heated and reaches a temperature of 84°. In certain confined seas the water becomes even hotter than this. Thus the waters of the Red Sea reach a temperature of 94°. This is owing to the fact that the Red Sea opens into the warm waters of the Indian Ocean, is situated near the burning deserts of Arabia and the Sahara and so evaporation is very rapid, has no rivers flowing into it, and its waters are highly charged with salt.

ac-cu'-mu-lates: gathers up.
brack'-ish: slightly salt; nearly fresh.
Coleridge, Samuel Taylor; a poet, was born in 1772. One of his best known poems is 'The Ancient Mariner.'
fath'-om: six feet.
ice'-berg: a huge mass of ice broken off from a glacier.
min'-im-um: the least; the lowest point.
re-strict'-ed: confined; small.
ther-mo'-me-ter: an instrument used for measuring heat.

4. THE OCEAN: DEPTH AND PRESSURE.

It is only of recent years that correct estimates have been formed of the depth of the ocean, and the latest discoveries show that even in the deepest places the depth is less than it was supposed to be. Early navigators had only the rudest means at their command for finding the depth of the ocean. Their general plan was to let out a length of rope with a weight attached to it. But they could not always tell when the weight touched the bottom, and no doubt they often paid out far more rope than was necessary. Further, they did not know that at various depths beneath the surface there are under-currents, and that these would seize hold of their sounding-rope and drift it a long way from the perpendicular. Thus in places where it has been proved by other methods than ordinary sounding that the depth is not more than three miles, no less than ten miles of line have been paid out, and it has run out so strongly that the slightest check in the paying-out apparatus has sufficed to break the sounding-line.


ARCTIC OCEAN
OCEAN
GREENLAND
NORTH AMERICA
SOUTH AMERICA
EUROPE
ASIA
AFRICA
AUSTRALIA
Reference
THE WORLD
Showing
DEPTHS

The sounding-line which has been used in recent expeditions consists of a long wire rope with a weight attached to it. This line is let out and hauled in again by means of an engine, and so but little time is wasted and but little drifting takes place. The weight which is fastened to the end of the line is so contrived that on reaching the bottom it becomes detached, leaving a pair of scoops at the end of the line. Early discoverers could not let down a heavy weight because the pressure increases so much at great depths that they would not have been able to haul it up again. But now a weight sufficient to take the line down straight and quickly can be used, and the scoops which remain are so arranged that they grab up a part of the sea-bottom and clutch it tightly directly the line is hauled off the floor. 'The general result,' says the late Professor Wyville Thomson, 'to which we are led by the careful and systematic deep-sea soundings which have been undertaken of late years is that the depth of the sea is not so great as was at one time supposed, and does not appear to average more than 2,000 fathoms, which is about equal to the mean height of the elevated table-lands of Asia.'

Greatest Depths.—In the Atlantic Ocean the deepest soundings have been taken between the West Indies and Bermuda, at a depth of about four and a half miles. In the Pacific Ocean the deepest soundings have been taken off the coast of Japan, at a depth of about five and a quarter miles. That is to say, the floor of the sea which lies to the east of Asia slopes down about as far as the Himalayas lift their lofty peaks towards the sky. Hence we see that, though our highest mountains tower grandly over the surrounding plains, and though the bed of the sea shelves down as far in deep valleys, yet the difference between the greatest height and the lowest depth on the earth's surface is only about eleven miles. When we consider that the diameter of the earth is about 8,000 miles, it will be seen that, comparatively speaking, the earth is almost smooth, and, though its surface is deeply scarred with mountain and valley, its wrinkles compared with its size are not greater than those which form in the cooled skin of a baked apple.

Pressure.—When a desire to discover more about the depths of the ocean first began to be general, expeditions were sent out to learn all they could about the currents, tides, winds, animal life, and, above all, to discover what lay on the floor of the ocean. Dredges were made consisting of strong nets attached to heavy beams. These were lowered, and, after being dragged for some distance, were hauled on board the ship and their contents were examined. Now it frequently happened that the beam which extended the mouth of the dredge was found to be broken when it reached the surface. At other times, instead of being broken the beam was seen to have shrunk, and the knots in it stood out from the surface for a space of an inch or more. Evidently a great force had been brought to bear upon the beam, and this force was the pressure of the water. A bottle filled with sea water and tightly corked, and then lowered to a considerable depth, would be brought up with the cork forced into the bottle. This was because the pressure of the water outside the bottle was so much greater than the pressure of the water inside.

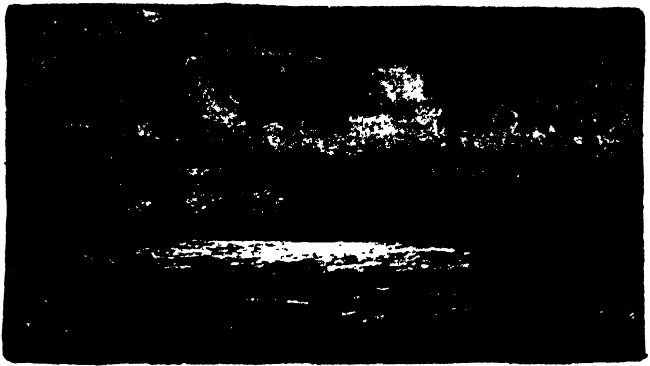
A cork floating upon the surface is held up by th upward pressure of the water, which is greater than th downward pressure of the cork. But a round lump, o iron placed upon the surface of the water sinks quickl because the downward pressure of the iron is greate than the upward pressure of the water. Fishes have t sustain a greater pressure at a depth of ten feet tha they have near the surface, and whales are specially provided with layers of porous and elastic fat so that the may withstand the pressure of the water at great depths Whalers say that it sometimes happens that when a whale is harpooned it dives to so great a depth that it cannot rise again, which means that the muscular power of the whale is not sufficient to overcome the downward pressure of the water.

It has been found that in sea water the pressure increases at the rate of about one ton on the square inch for each 1,000 fathoms of increasing depth. So that the inhabitants of the floor of the ocean at a depth of 2,500 fathoms have to sustain a pressure of 2½ tons upon each square inch of surface! This seems truly wonderful when we remember that at the earth's surface living beings have to sustain an atmospheric pressure of only 14 lbs. on the square inch. Yet there are delicately organised animals, very small, it is true, living at these great depths, and their structure is enabled to bear this great pressure because their frames are so wonderfully adapted to the conditions under which they live. For they are so constructed that the water flows through and through them, and thus, being subjected to the same pressure from within as well as from without, they are able to bear this enormous pressure and feel no more inconvenience from it than we do from the pressure of the air.

Sea water is almost incompressible; that is to say, a given quantity cannot be made to occupy a much less space. Hence at the greatest depths its density is scarcely perceptibly increased.

A knowledge of the rate at which pressure increases according to depth has been used to find the depth. By an ingenious but simple contrivance attached to the end of the sounding-line, the amount of pressure upon the square inch can be measured. Having obtained the pressure, a very easy calculation will give the depth.

de-tach'-ed: unfastened.
den'-si-ty: the proportion of mass to bulk or volume.
har-poon'-ed: a harpoon is a barbed weapon used for killing whales.
in-com-press'-ible: that cannot be squeezed into less space.
por'-ous: full of small holes called pores.
suf-fic'-ed: was sufficient or enough.



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5. THE OCEAN: COLOUR OF SEA WATER.

The sea is not colourless. Its crystal mirror not only reflects the bright sky or the passing cloud, but naturally possesses a pure bluish tint which is only rendered visible to the eye when the light penetrates through a layer of water of considerable depth. During a voyage from Gibraltar to Spithead, Professor Tyndall made a series of experiments upon the colour of the water at different places on the route. He filled a number of bottles with sea water at various places on the voyage, and, having sealed them carefully, he examined them after he reached England. The first sample examined was of water taken in Gibraltar harbour; this was green in colour, and was thick with fine particles of suspended matter. The second was taken about two miles from Gibraltar, and, though of a brighter green colour, was also thick with very fine particles. The third was taken some little distance at sea, and was of a very bright green colour, but was not so full of particles of matter. From the examination of these three samples, it will be seen that as the green colour became brighter the suspended matter diminished in amount.

'Previous to the fourth observation, our excellent navigating lieutenant steered along the coast, thus avoiding the adverse current which sets in through the strait from the Atlantic to the Mediterranean. He was at length forced to cross the boundary of the Atlantic current, which was defined with extraordinary sharpness. On the one side of it the water was of a vivid green, on the other a deep blue. Standing at the bow of the ship a bottle could be filled with blue water, while at the same moment a bottle cast from the stern could be filled with green water. Two bottles were secured, one on each side of this remarkable boundary. In the distance the Atlantic had the hue called ultramarine; but looked fairly down upon, it was of almost inky blackness—black qualified by a trace of indigo.'

Upon examining the other bottles, it was found that whereas out in deep water off Tarifa the colour was blue and the water was free from matter, it became green or yellowish green in and near Cadiz, and was also very thick. In the Bay of Biscay the water was of a deep blue colour and was almost pure, but on approaching the shores of England the water was again found to be green and thick with matter.

'The green colour of the sea has now to be accounted for; and here, again, let us fall back upon the sure basis of experiment. A strong white dinner-plate had a lead weight securely fastened to it. Fifty or sixty yards of strong hempen line were attached to the plate. My assistant occupied a boat fastened as usual to the davits of the "Urgent," while I occupied a second boat nearer the stern of the ship. He cast the plate as a mariner heaves the lead, and by the time it reached me it had sunk a considerable depth in the water. In all cases the hue of this plate was green. Even when the sea was of the darkest indigo, the green was vivid and pronounced. I could notice the gradual deepening of the colour as the plate sank; but at its greatest depth, even in indigo water, the colour was still a blue-green. Thus, I think, the greenness of the sea is physically connected with the matter which it holds in suspension.'

The bright blue of the Mediterranean is found all over the deep pure ocean, not only in the tropical and temperate zones, but also in the regions of eternal frost. Scoresby speaks with enthusiasm of the splendid blue of the Greenland seas; and all along the great ice barrier which under 77° S. lat. obstructed the progress of Sir James Ross towards the Pole, that illustrious navigator found the waters of as deep a blue as in the Mediterranean.

The peculiar colouring of the Red Sea, from which it has derived its name, is owing to the presence of a microscopic seaweed floating at the surface of the sea, and even less remarkable for its beautiful red colour than for its enormous numbers and the rapidity with which it grows.

In some parts of the Greenland seas the water is of an olive-green colour. This is caused by the presence in immense numbers of small yellowish Medusæ of from one-thirtieth to one-twentieth of an inch in diameter. The position of this coloured water is between 74° and 80° N. lat., but it varies with the currents, often forming isolated stripes and sometimes spreading over two or three degrees of latitude. It is here that the giant whale of the north finds his richest pasture-grounds, which at the same time invite man to follow on his track.

The essential colour of the sea undergoes much more frequent changes over large spaces, from enormous masses of minute Algæ and countless hosts of small sea-worms floating or swimming on its surface.

Mr. Darwin says in his 'Naturalist's Voyage Round the World': 'On the coast of Chili the "Beagle" one day passed through great bands of muddy water, exactly like that of a swollen river; and again, a degree south of

Valparaiso, when fifty miles from the land, the same appearance was still more extensive. Some of the water placed in a glass was of a reddish tint; and, examined under a microscope, was seen to swarm with minute animalculæ darting about. They are quite invisible to the naked eye, only covering a space equal to the square of the thousandth of an inch. Their numbers were infinite; for the smallest drop of water which I could remove contained very many. In one day we passed through two spaces of water thus stained, one of which alone must have extended over several square miles. What incalculable numbers of these microscopical animals! The colour of the water, as seen at some distance, was like that of a river which has flowed through a red clay district; but under the shade of the vessel's side it was quite as dark as chocolate. The line where the red and blue water joined was distinctly defined. The weather for some days previously had been calm, and the ocean abounded to an unusual degree with living creatures.'

ad'-verse	in a contrary direction.
Al'-gæ	a division of plants embracing seaweeds.
an-i-mal'-cu-læ	minute animals.
is'-o-la-ted	cut off from others; solitary; alone.
lieu-ten'-ant	an officer who in the navy ranks next below a commander; in the army, next below a captain.
route	the road or way.
sus-pend'-ed	held up, in this case by the water.
Me-du'-sæ	jelly-fishes.

6. WAVES AND THEIR WORK.

'The movements of the sea,' says Humboldt, 'are of a threefold description: partly irregular and transitory, depending upon the winds, and occasioning waves;

partly regular and periodical, resulting from the attraction of the sun and the moon (**tides**); and partly permanent, though of unequal strength and rapidity at different periods (**oceanic currents**).'

Who has ever sojourned on the coast, or crossed the seas, and has not been delighted by the aspect of the waves, so graceful when a light breeze curls the surface of the waters, so sublime when a raging storm disturbs the depths of the ocean?

Those who are placed for the first time on a stormy sea discover with wonder that the large waves which they see rushing along with a velocity of many miles an hour do not carry the floating body along with them, but seem to pass under the bottom of the ship with scarcely a perceptible effect in carrying the vessel out of its course. In like manner floating pieces of wood are not carried towards the shore with the rapidity of the waves, but are left nearly in the same place after the wave has passed them. Even when the tide is ebbing away from the shore the waves still rush on and break, though they are moving in a direction quite contrary to the ebbing tide.

What then is the movement of the waves and how are waves produced? Let us take a familiar example. If we drop a pebble into a pond, there is a small splash as it strikes the water, and as the stone disappears a movement begins all round the spot where it struck. Rings of water, one within the other, move outwards from the centre, the outside one ever growing larger and larger, and also weaker and weaker, as it progresses from the starting-point, until at length the ripples break upon the shore and the water is still again.

These ripples are perfectly regular in form, circle within circle, and as they move onward each keeps its place behind the other. There is no crowding or hurrying. Should they meet a cork floating on the surface, they do not carry it onward with them, but gently rock it up and down, and, having passed it, the cork is left in the same place in which it was before the ripples met it. A swimmer going through the waves merely feels himself gently raised and then lowered as a wave passes him,

OCEAN WAVES.

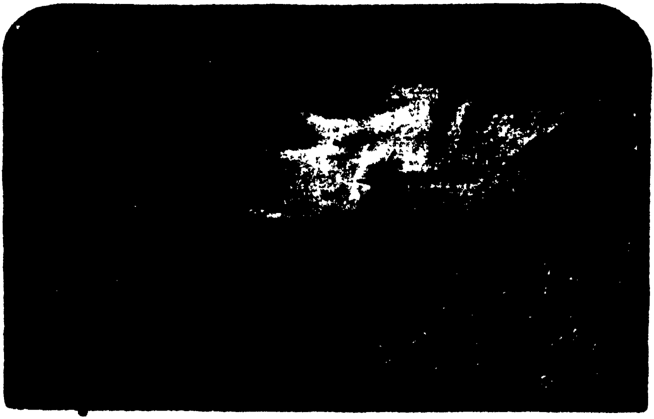
but his progress is not retarded except when the breaking surf dashes against him.

If we blow upon a basin of water, the movement of the air is at once imparted to the water, and the surface is thrown into a succession of ripples. In the same way each puff of wind at sea strikes the water in a slanting direction, and heaps it up a little into a ridge or wave with its steep side away from the wind. Then the crest falls, and the water sinks down into a trough as deep below the mean surface as the wave was above it. In this way the motion of the wave may be propagated over a broad expanse of water. If the wave should meet a boat in its course, the boat is simply rocked up and down, and is not propelled onward. This is because the motion of the water as caused by waves is merely that of undulation, and the water itself is not carried forward.

In this way a wave is produced, and when the wind blows strongly and steadily wave follows wave in endless progression, and the whole sea is furrowed with the swiftly moving ridges.

When the wave reaches the sea-shore the under part strikes the bottom, and the onward progress of the wave is stopped from below; the upper part instantly becomes top-heavy, and, curling forward, its crest falls with resounding thud upon the beach. In the open sea when the wind is very strong the tops of the waves are snatched off by the passing gusts and drive in clouds of spray, so that the whole surface of the sea is a mass of driving foam, with here and there the beautiful colours of rainbows showing faintly through the mist as the sun shines upon it.

Height of Waves.—In shallow water such as that of the North Sea the height of the waves rarely exceeds eight to ten feet, and in the open ocean the highest waves, measured from crest to trough, do not exceed forty feet. Further, the wave vibration extends but a short distance below the surface, and at a depth of 2,000 feet the motion of the largest waves is scarcely felt at all. Here, no matter how wildly the wind roars above and the driving gale lashes the surface into sheets of foam, myriads of animals live and die in perfect security and repose.



NEARLY A WATERSPOUT.

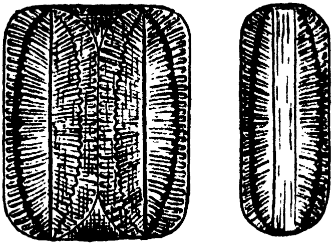
Pressure of Waves.—It has been calculated that waves sometimes move with a velocity of as much as thirty miles an hour. Masses of water moving so rapidly must strike heavy blows when they fall upon the shore or break against a ship. On the western coasts of Britain the long waves from the Atlantic even in summer roll in with a pressure of 600 lbs. to the square foot, while in winter they have been known to exert a pressure of from three to four tons upon the same space. No wonder that these coasts are torn and riven into every imaginable form of pinnacles, skerries, caves, and boulders. The great storm of 1824, which carried away part of the breakwater at Plymouth, lifted huge masses of rock, from two to five tons in weight, from the bottom of the weather side and rolled them fairly to the top of the pile. One block of limestone weighing seven tons was washed round the western extremity of the breakwater and swept to a distance of 150 feet.

per′-ma-nent: abiding; constant; not shifting.
pe-ri-od′-ic-al: coming at certain fixed times.
pro′-pa-ga-ted: spread abroad.
riv′-en: torn or split.
tran′-si-to-ry: fleeting; not constant.
trough: a hollow.
un-du-la′-tion: an up-and-down or to-and-fro movement.
ve-lo′-ci-ty: rate of motion.

7. LIFE AT THE OCEAN SURFACE.

THE sea swarms with life. Its inhabitants may be divided into three great classes, grouped according to the varying depths at which they live.

Any one walking upon the sea-shore, upon the belt between high and low-water mark can see abundant life, consisting mostly of crabs, sea-anemones, and various kinds of small shell-fish, such as periwinkles, limpets, cockles, and many others. All these form a class to themselves, and because they live on the shore are called the shore fauna, the latter word being a term applied to animal life. Then there are the animals which live at the surface of the ocean, and they form the oceanic fauna. And, thirdly, there is a class of which we know but little, comprising all life at the bottom of the oceans, and called the deep-sea fauna.


DIATOMS (*highly magnified*).

In the cold seas of the far north and south ships often pass for miles through water which swarms with very small plants called diatoms. So abundant are they that they give the water a yellowish-green appearance. A fine muslin net dipped overboard will come up quite full of diatoms, which look like a soft jelly. In warmer parts of the ocean there are myriads of other minute seaweeds of a reddish-brown colour. They are shaped like little fagots or round bundles of sticks. In the Atlantic Ocean there is a large area called the Sargasso Sea. For thousands of square miles this sea is covered with immense masses of Gulf-weed, forming floating islands. The sailors of Columbus's ships who saw them for the first time thought they were solid, and wanted to get overboard and walk upon them. This weed supplies the food of enormous quantities of animal life. Fishes of all kinds swim amongst it, and myriads of minute animals live a happy and constantly active life upon it.

One of the most remarkable features of the animals which live on the ocean surface is that they are almost completely transparent and glass-like in appearance, and so are concealed from their enemies the birds, which hover over the surface in search of food, and fishes of various kinds which are always on the look-out for prey. One kind is entirely transparent except its liver and intestine, and as it drifts along it seems to be merely a shred of floating seaweed. This kind develops a chain of young ones as buds inside it, and then sets the chain free to shift for itself.

PORTUGUESE MAN-OF-WAR.

Though most of these animals are transparent, there are some which are of a blue colour and are so like the colour of the water that it is almost impossible to see them. One of the best known of this kind is the Portuguese man-of-war. This is not a single animal, but is a colony of animals, and hanging beneath the float are the various individuals which make up the colony. Some of them have long tentacles or feelers with which they catch the food, but they have no stomachs. They pass the food to the inner parts of the float, where live larger animals which are nearly all stomach, and these digest the food and send the nourishment to the whole colony.

A most interesting peculiarity must be noticed in the eyes of these animals. As with animals which live at the bottom of the deep sea, so it is with those on the surface. Many of them are quite blind, and in others the eyes are so large that the animals look as 'if their great work in life was to carry their eyes about.' One beautiful little animal is often called the oceanic butterfly. It is about an inch long, has a beautiful shell, and a pair of wings by means of which it flutters through the water like a butterfly. It has two little streamers hanging out from the shell. These seem to balance it, and if either gets broken the animal can no longer go straight, but swims round and round in the most ridiculous fashion. Evidently they guide the animal in some way which we do not understand, for it has no eyes nor any trace of eyes.

ARGONAUT.

Most of these animals which live at the ocean surface are nocturnal in their habits—that is to say, they come up to the surface during the night, and in the daytime they sink for some distance below. They also go down in stormy weather. It is probable that they never go below forty or fifty fathoms from the surface. The reason for their going below in the daytime is probably due to the conditions under which they get their food. They live upon the vegetable life which is so abundant in the waters of the ocean. But this can only extend as far as sunlight reaches, and, though we cannot tell exactly, it is probable that the sun's rays do not penetrate farther than about fifty fathoms. Hence these animals make the most of the food found in the zone in which they live. At night they come to the surface, where there is then only just sufficient light for them to see their food, whereas in the daytime they go down to the farthest depths to which the light reaches.

We have only very briefly spoken of the life at the ocean surface, but it must be remembered that the sea teems with life, and that the myriads and myriads of these minute creatures form the food of the larger animals and fishes. Some of the best known of these will be described in other lessons.

noc-tur'-nal: going abroad or seen only at night.

Sargasso Seas: these seas are found in each of the oceans the waters of which extend into the Tropics; generally in the slack water around which ocean currents flow.

8. OCEAN CURRENTS.

OCEAN currents are produced by several distinct causes, some of which correspond in their nature to the main causes which create and vary the direction of winds. It has been noticed that the great ocean currents move in the same direction as the prevalent winds, and observers have come to the conclusion that the surface drifts or currents are caused by the winds. Just as warmer air rises, and currents of cooler air rush in to take its place, so warmer water ascends, and currents of cooler water flow in to replace it, the density of both air and water increasing or decreasing with decrease or increase in their temperature. Thus differences of temperature set both air and water in circulation. If we consider this fact we shall readily discover the main cause of some of those ocean currents which exert so great an influence on the climate of certain parts of the world.

In the tropical regions, the greater heat of the direct rays of the sun raises the temperature of the surface water to a comparatively high point, but it has of late years been found that this higher temperature does not extend to any considerable depth in the waters below. Thus from the reports of the 'Challenger' we find that the surface water of the Gulf Stream has a temperature of 75° soon after leaving the Strait of Florida, whereas the temperature of the water below it is only 35°. Further, in the deepest parts of the ocean it was always found that the temperature of the water was only just above freezing-point, and in some parts it fell even below the freezing-point of fresh water. On the other hand, in the frigid regions the vast icefields and the bitter frosts chill the surface waters, which sink by reason of their greater density and displace the warmer waters below. By this means under-currents are created, which move from the frigid regions and displace the warmer waters nearer to the Equator. As the latter are thus forced upwards, they flow as surface currents from the tropical regions to the north and to the south. Consequently we find several cold under-currents flowing *towards* the equator, and warmer surface currents flowing *from* it. The cold currents sink so gradually that they continue to chill the atmosphere during the first part of their course, while the temperature of the warm currents falls so slowly as they flow towards the Poles, that several of them retain their warming influence almost to the borders of the frigid regions. It is necessary also to explain that the courses of the surface currents from the Equator to the north or south are modified by the action of the prevailing winds, as well as by the position and shape of the coast-lands with which they come in contact. Indeed, some currents are caused entirely by the pressure of the winds blowing constantly in the same direction.

Leaving the consideration of the tides to another lesson, it may now be said that there are three main influences affecting the movements in the waters of the oceans:—(1) The unequal heating of the waters in different parts, which causes an upward and a downward movement of the waters between the surface and the depths, and also a northward and a southward movement between the Equator and the Poles. This explains both the cold currents which move constantly from the Arctic regions, and the cold creep which drifts from the Antarctic Ocean towards the Equator. (2) The action of the prevalent winds, which gives direction and velocity to the surface currents thus formed. The best example of currents caused in this way is afforded by the equatorial currents which move in the same direction as the

Trade Winds. It must, however, be added that some persons hold that the rotation of the earth modifies the direction of ocean currents somewhat in the same way that it modifies the course of some of the winds. And (3) Currents are also caused by differences in saltness. Thus in the Arctic Seas it happens in the summer that the surface water is comparatively fresh owing to the melting of the ice. This water is less dense than the salter water beneath it, and overflows as it were at the surface, thus causing movements in the waters.

Currents other than tides may be divided into three classes:—(1) [1] **Constant currents**, produced by differences in temperature, and modified in their courses by winds. The great constant currents are the **Equatorial Currents** of the Atlantic, Pacific, and Indian Oceans. These flow steadily from east to west across the oceans, and owe their direction largely to the trade winds which blow in the same direction. Another strong current produced by differences of temperature is the Peruvian current, which carries a body of very cold water from the Antarctic regions, along the western coast of South America. (2) **Periodic currents**, due to the action of land and sea breezes, and monsoons. And (3) **Counter-currents**, which flow side by side but in contrary directions to the great currents. There is also to be recognised a general 'creep' of cold polar water towards equatorial regions, and a general drift of warm water towards the Poles.

frig'-id: very cold; the frigid zones lie around the Poles.

Mon'-soons: winds which for half the year blow from the N.E. and the other half from the S.W. across the south coasts of Asia.

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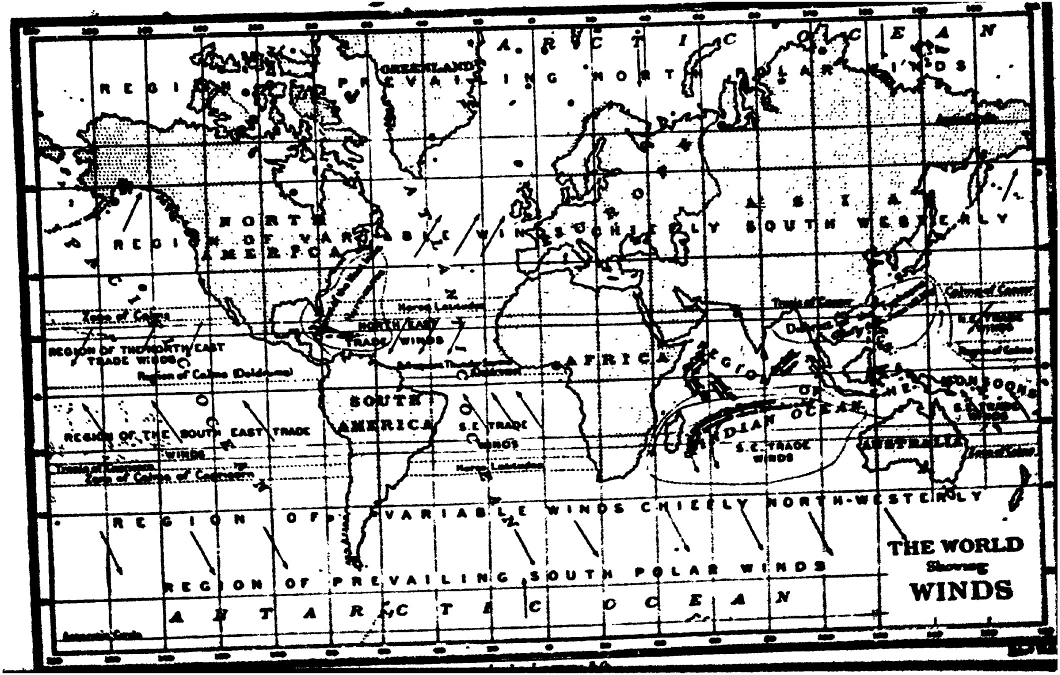
[1] See folding-out map.

9. WINDS.

We have seen that the chief currents in the oceans follow the direction of the prevailing winds, and to understand the whole subject it is necessary for us to see how the winds are caused. The chief cause of setting the air in motion is the difference of temperature of the air in different places. If we take an ordinary air-balloon, and tie it up tightly so that the air inside of it cannot escape, and then hold the balloon near the fire, we shall see that it will gradually swell and may even burst. Now what makes the balloon swell and burst? It is because the air inside has become heated, and as it does so it expands or becomes larger, and therefore requires more room. When the balloon swells it is because the air inside is pushing outwards in all directions, and if the balloon be pricked with a pin, the air rushes out with a whistling noise.

If we could watch the direction in which this warm air travelled after leaving the balloon we should see that it moved upwards. This is because hot air when it expands also becomes lighter or less dense, and so when it is freed and mixes with colder air the latter pushes downwards with the greater force, and so the lighter air is squeezed upwards. This may be noticed any evening in a room where the gas is lighted. If you stand on a chair so that your head is near the ceiling, you will find the air becomes hotter the higher you reach. Hence we find that hot air rises, and so a circulation or constant movement of the air in a room is kept up.

Now this is exactly what is happening in various parts


THE WORLD
Showing
WINDS
ARCTIC OCEAN
REGION OF PREVAILING NORTH POLAR WINDS
GREENLAND
NORTH AMERICA
REGION OF VARIABLE WINDS CHIEFLY SOUTH WESTERLY
ASIA
EUROPE
AFRICA
SOUTH AMERICA
AUSTRALIA
INDIAN OCEAN
Zone of Calms
REGION OF THE NORTH EAST TRADE WINDS
NORTH EAST TRADE WINDS
Horse Latitudes
Region of Calms (Doldrums)
Doldrums
REGION OF THE SOUTH EAST TRADE WINDS
S.E. TRADE WINDS
Tropic of Capricorn
Zone of Calms of Capricorn
Tropic of Cancer
Calms of Cancer
N.E. TRADE WINDS
Region of Calms
REGION OF THE MONSOONS
S.E. TRADE WINDS
REGION OF VARIABLE WINDS CHIEFLY NORTH-WESTERLY
REGION OF PREVAILING SOUTH POLAR WINDS
ANTARCTIC OCEAN
Antarctic Circle

of the earth, and as the regions within the Tropics form the hottest portion of the globe, it is there we should expect to see this law operating on the vastest and grandest scale. Where the sun is directly overhead, or nearly so, the air at the surface of the earth becomes very highly heated, and therefore rises in vast volumes. In this way an upward movement of the air begins. When we consider the millions of square miles of land and sea which lie between the Tropics, and when we think of the intense heat of those regions, where the sun pours its beams vertically or nearly so all the year round, we shall see that at its largest part the earth is enveloped in a belt of hot air which is ever moving upwards. And as it moves, other volumes of cooler air are drawn inwards to fill its place.

Hence we see that differences of temperature will cause two distinct movements of the air. But if we followed the course of the hot air which rises very high, we should see that, after flowing over the layers of air beneath it, this air in its turn also becomes cool, and then gradually falls towards the surface again.

Now from what we have said, we should expect to find near to and within the Tropics that the air is constantly moving from the north and the south towards the equatorial regions. This is so, but the direction of the winds which are caused in this way is not due north and south. We must remember that at the Equator the earth revolves more quickly upon its axis than it does anywhere else, and that the revolution becomes slower and slower as we approach the Poles. So that bodies of air moving towards the Tropics from the north and south are all the while approaching places which are moving round faster than the places from which they started; and being fluid bodies, they do not acquire this new rate of motion fast enough to keep up with the solid earth. Hence they lag behind, and as the earth turns from west to east these moving currents of air, or winds as we call them, acquire a motion towards the west.

In this way the most important winds of the earth are caused, and as they blow steadily all the year round, and sailors can always rely upon finding them in certain latitudes, they are called the **Trade Winds**; the **North-Easterly Trade Wind** in the North Atlantic, and the **South-Easterly Trade Wind** in the South Atlantic. The north-east trades blow constantly between 9° and 27° N. lat., and the south-east trades between 3° N. lat. and 25° S. lat. The latter having a greater width of sea to blow over are fresher and stronger than the former. It was the north-east trade wind which carried Columbus safely across the Atlantic, and the south-east trade wind which wafted Magellan's leaky vessels over the Pacific. Owing to the vast number of islands in the latter ocean the trade winds are to a certain extent broken up, and do not blow so constantly or so steadily as in the Atlantic. Owing to the masses of land in the northern tropical regions there is only one trade wind in the Indian Ocean.

Between the regions of the trade winds lies the dreaded girdle or zone of the equatorial calms, the well-known **Doldrums**, where dreadful storms alternate with long calms; where:—

'Down dropt the breeze, the sails dropt down,
'Twas sad as sad could be;
And we did speak only to break
The silence of the sea.
Day after day, day after day
We stuck, nor breath nor motion;
As idle as a painted ship
Upon a painted ocean.'

Outside the region of the trade winds, for ten or twelve degrees on each side, is a belt called the **horse-latitudes**, where sailors also find alternations of calm and storm.

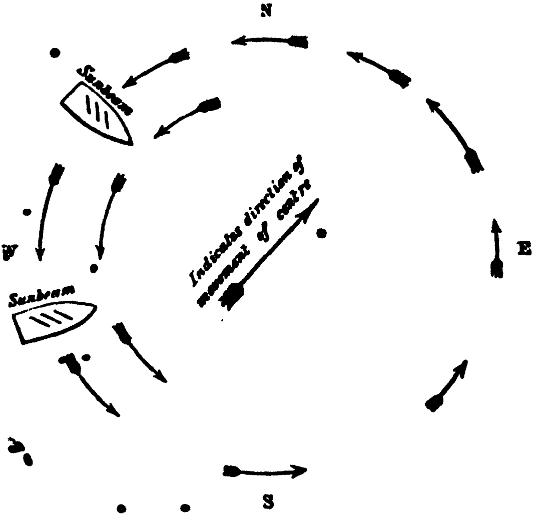
It has been already shown that the hot air which rises within the Tropics overflows towards the north and south, and, becoming cooled, gradually sinks again towards the surface. But this air is moving from quickly revolving regions to slower ones, and as it moves north and south it is moving faster than the land over which it passes. Hence it acquires a direction towards the east, and causes south-westerly winds in the north and south temperate zones.

Hence, we see that just as in the ocean there is an upward and downward movement of the waters owing to differences of temperature and saltness, as well as a constant movement of warm water to the north and south and of cold water towards the Tropics, so in the air-ocean above there is a constant movement upwards and downwards, and of hot air to the north and south, while the cooler air moves towards the Tropics.

al-ter-na'-tions: changes from one to the other.
en-vel'-op-ed: surrounded by.
cir-cu-la'-tion: moving round.
Trop'-ics: the parts of the earth between the Tropic of Cancer on the north and the Tropic of Capricorn on the south.

10. CYCLONES AND WATERSPOUTS.

IN tropical regions there are occasionally dreadful storms of swiftly moving winds which are called **typhoons**, **cyclones**, or **tornadoes**. These storms are great rotatory winds that move along a curved line in increasing circles. In the northern hemisphere the rotatory movement follows a direction contrary to that of the hands of a clock; while the opposite takes place in the southern hemisphere. Besides the circular motion around the centre, the centre itself has a progressive movement. The space over which these circular storms extend varies



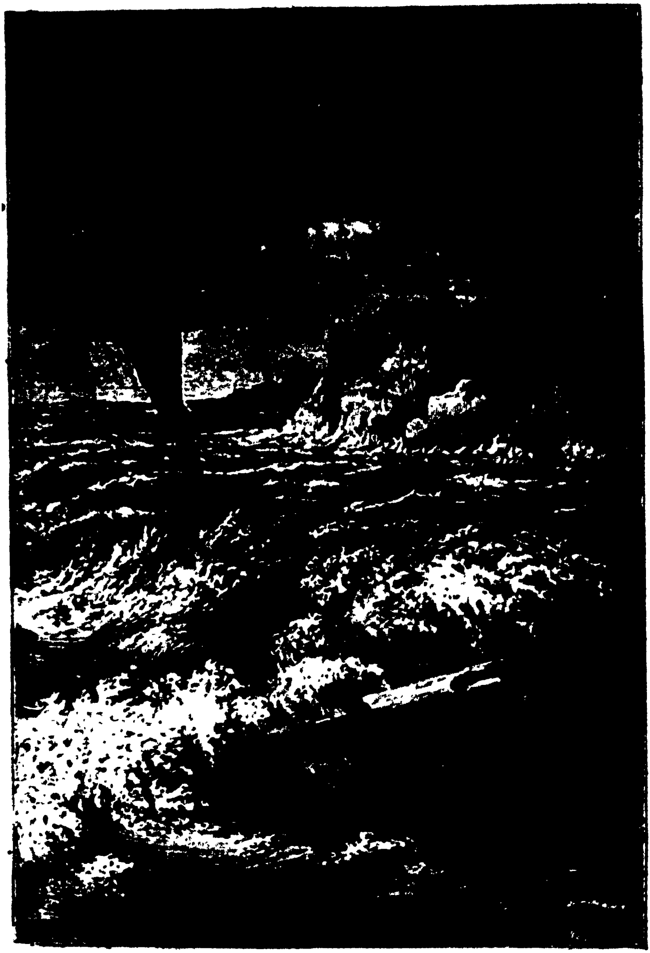
THE TRACK OF A TORNADO.

from twenty or thirty to some hundreds of miles; and they expand and lose something of their violence as they advance into the higher latitudes.

A knowledge of the laws which regulate the movements of storms is of great importance to the mariner, since it points out to him the direction he has to give his ship to gain the external limits of the tornado, and thus remove it from danger. Sometimes these storms burst with unexampled fury over the islands of the West Indies and do an immense amount of damage.

Waterspouts are formed by two winds blowing in opposite directions and raising or sucking up the water in their vortex. They generally form a double cone; the superior part, with its apex downwards, consisting of a dense cloud, while the inferior cone, the apex of which is turned upwards, consists of water, which is thus sometimes raised to a height of several hundred feet. Waterspouts seldom last longer than half an hour. Their course and movement are very irregular—straight forwards, in zigzag lines, alternately rising and falling, stationary, slow, or progressing with a rapidity of thirty miles an hour. They are more frequent near the coast than in the high seas, and are most commonly seen in very hot climates. They seem to occur particularly in regions where calms frequently alternate with storms, which is not to be wondered at, since they owe their origin to miniature storms or whirlwinds.

A Cyclone in the Barbadoes.—'After midnight the uninterrupted flashing of the lightning became terrible and grand, and the storm raged fearfully. The upper regions of the atmosphere were meanwhile furrowed with inces-



WATERSPOUT.

sant lightnings; but these vivid flashes were surpassed in brilliancy by the streams of electric fire which exploded in every direction. A little after two o'clock the howling of the storm was such that no language is able to describe it. A few minutes later the lightning ceased, and the tenfold darkness which now enveloped the town was indescribably fearful. Fiery meteors now fell from the sky; one particularly, of a globular form and blood-red colour, dropped down from a great height.

'Immediately afterwards the storm again broke in from the west with indescribable fury, driving thousands of ruins before it like missiles. The strongest buildings shook to their foundation; nay, even the earth trembled as the destroyer passed over it. No thunder was to be heard for the dreadful howling of the wind; the roar of the ocean whose mighty waves threatened to destroy all that the other elements might spare, the rattling of the tiles, the falling in of roofs and walls, formed altogether a terrific chaos of sounds. After five, the storm abated, and now the falling of the tiles and bricks was distinctly heard, as they fell to the ground after having been carried high into the air by the last gusts of wind.

'As soon as the twilight rendered objects visible, the writer went upon the quay. The rain fell with such violence that it hurt the skin, and so thick that one could not see farther than the end of the mole. The aspect was beyond all description sublime. The waves rolled gigantically towards the shore as if nothing could withstand their violence; but as soon as they broke upon the quay they lost themselves under rubbish of every description. Beams, cordage, casks, and goods formed a continuous undulating mass. Only two vessels remained upright; many were overturned or lay on the lee side in shallow water. From the tower of the cathedral a scene of universal destruction presented itself. The aspect of the country was like that of a desert; it seemed as if fire had gone over the land, devouring and burning everything before it. Some few trees stripped of their leaves and branches presented a cold and wintry aspect, and the numerous country-houses about Bridgetown formerly shaded with dense bushes now lay bare and in ruins.'

in-cess′-ant: without ceasing.
min′-i-a-ture: on a very small scale.
ro′-ta-tory: moving round and round.
sta′-tion-ary: fixed in one place.
vor′-tex: the hollow centre caused by a mass of fluid whirling very rapidly.
the mole: a breakwater used as a landing-place running out into the sea.

11. THE OCEAN.

Roll on, thou deep and dark blue Ocean—roll!
Ten thousand fleets sweep over thee in vain;
Man marks the earth with ruin—his control
Stops with the shore;—upon the watery plain
Thy wrecks are all thy deed, nor doth remain
A shadow of man's ravage, save his own,
When, for a moment, like a drop of rain,
He sinks into thy depths with bubbling groan,
Without a grave, unknelled, uncoffined, and unknown.

The armaments which thunderstrike the walls
Of rock-built cities, bidding nations quake,
And monarchs tremble in their capitals,
The oak leviathans, whose huge ribs make

Their clay creator the vain title take
Of lord of thee, and arbiter of war;
These are thy toys, and, as the snowy flake,
They melt into thy yeast of waves, which mar
Alike the Armada's pride, or spoils of Trafalgar.

Thy shores are empires changed in all save thee—
Assyria, Greece, Rome, Carthage, what are they?
Thy waters wasted them while they were free,
And many a tyrant since; their shores obey
The stranger, slave, or savage; their decay

Has dried up realms to deserts:—not so thou,
Unchangeable save to thy wild waves' play—
Time writes no wrinkle on thine azure brow—
Such as creation's dawn beheld, thou rollest now.

Thou glorious mirror, where the Almighty's form
Glasses itself in tempests; in all time,
Calm or convulsed—in breeze, or gale, or storm,
Icing the Pole, or in the torrid clime

Dark-heaving;—boundless, endless, and sublime—
The image of Eternity—the throne
Of the Invisible; even from out thy slime
The monsters of the deep are made; each zone
Obeys thee; thou goest forth, dread, fathomless, alone.

And I have loved thee, Ocean! and my joy
Of youthful sports was on thy breast to be
Borne, like thy bubbles, onward: from a boy
I wantoned with thy breakers—they to me
Were a delight; and if the freshening sea
Made them a terror—'twas a pleasing fear,
For I was as it were a child of thee,
And trusted to thy billows far and near,
And laid my hand upon thy mane—as I do here.

LORD BYRON.

ar′-ma-ments: the heavy guns which a fleet of war-ships carries.
ar′-bit-er: one who decides between two opposing parties.
As-sy′-ri-a: formerly a powerful kingdom traversed by the R. Euphrates.
Car′-thage: at one time a powerful city in the north of Africa on the shores of the Mediterranean.
le-vi′-a-than: anything of huge size; here refers to large ships. In the book of Job the word is used for the name of a huge aquatic animal.
wan′-ton-ed: sported with.

12. THE INHABITANTS OF THE SEA: CETACEANS. (I.)

OF all the living creatures that people the immensity of the ocean, the **cetaceans**, or the whale family, are the most perfect. Their anatomical construction renders them in many respects similar to man, and their heart is susceptible of a warmth of feeling unknown to the coldblooded fishes, for the mother shows signs of attachment to her young, and forgets her own safety when some danger menaces her offspring. Like man, the cetacean breathes through lungs, and its heart pumps to all parts of its body streams of *warm* red blood. The cetaceans are distinguished, moreover, from the fishes by the bringing forth of living young, by a greater quantity of blood, by the smoothness of their skin, under which is found a thick layer of fat, and by their blow-hole, which is situated at the top of the head, and corresponds to the nostrils of the quadrupeds, not for the purpose of smelling, but merely as an organ of respiration.

The mechanical principle of propulsion is the same in the whale and the fishes, the broad tail being swept to and fro through the water, and so driving the creature forward, just as a sailor propels a boat by working a single oar backwards and forwards in the stern. The screw-propeller of our steamers is nothing but a clumsy imitation of the fish's tail, which is not only a mere instrument of propulsion, but a rudder by which the course is directed. There is this difference, however, between the fish and the whale, for while the former moves its tail from side to side, the whale moves its tail upwards and downwards.

The power wrapped up in a whale's tail is almost beyond conception. The weight of a full-grown whale may be appreciated when the reader reflects that the famous elephant Jumbo would have to be multiplied many times before his weight would equal that of a large whale. Yet the late Captain Scott, R.N., says that when on the quarterdeck of his own ship he repeatedly saw the whales leaping in mere play so high out of the water, that the horizon was clearly visible under them. Now Captain Scott lived to be nearly a hundred years old, and when he was in active service the quarterdeck of a man-of-war was at least thirty feet above the water; add to this measurement his own height (he being rather a tall man), and the reader can then appreciate the terrific power of the animal's tail.

Although the whale does not need, and therefore does not possess, the hind-limbs, it does need the fore-limbs, though, when covered with skin, they look more like the fins of a fish than the fore-limbs of a mammal.

Though the whale is the largest of all mammals, it has a very cowardly nature. Besides man, a vast number of enemies, great and small, persecute the whale. The **sword-fish** and the **thresher**, a species of shark, often attack him conjointly and in packs. As soon as his back appears above the water, the threshers, springing several yards into the air, descend with great violence upon the object of their rancour, and inflict upon him the most severe slaps with their long tails, the sound of which resembles the report of distant musketry. The sword-fish, in their turn, attack the distressed whale, stabbing from below; and thus beset on all sides, and bleeding from countless wounds, the huge animal, though dealing the most dreadful blows with its enormous tail, and lashing the crimsoned waters into foam, is obliged to succumb at last.

Fishermen relate that the whale and saw-fish, whenever they come together, engage in deadly combat, the latter invariably making the attack with inconceivable fury. The whale, whose only defence is his tail, endeavours to strike his enemy with it; and a single blow would prove mortal. But the saw-fish with astonishing agility shuns the tremendous stroke, bounds into the air, and returns upon his huge adversary, plunging the rugged weapon with which he is furnished into his back. The whale is still more irritated by this wound, which only becomes fatal when it penetrates the fat; and, thus pursuing and pursued, striking and stabbing, the engagement only ends with the death of one of the unwieldy combatants.

The home of the Greenland whale is confined to the high northern seas, where it has been met with in the open waters or along every ice-bound shore as far as man has penetrated towards the Pole. The southern limit of its excursions seems to be about 60° N. lat.

The fin-fish or northern **rorqual** wanders farther south, and is sometimes stranded on the shores of the British Islands. There are several other kinds of whales, the best known of which is the **sperm whale** or cachalot. The peculiar fat or sperm which renders the cachalot so valuable is chiefly situated in the head. Junk is the name given by the fishermen to a solid mass of soft, yellow, and oily fat, weighing between two and three tons, based on the upper jaw, and forming the front and lower part of the snout; while the cavity called *case* is situated beneath and to the right of the spouting canal, and corresponds to nearly the entire length of that tube. It is filled with a very delicate web of cellular tissue, containing in large cells a limpid and oily fluid, which is liberated by the slightest force. The quantity, chiefly spermaceti, contained in this singular receptacle is often very considerable, nearly 500 gallons having been obtained from the case of one whale.

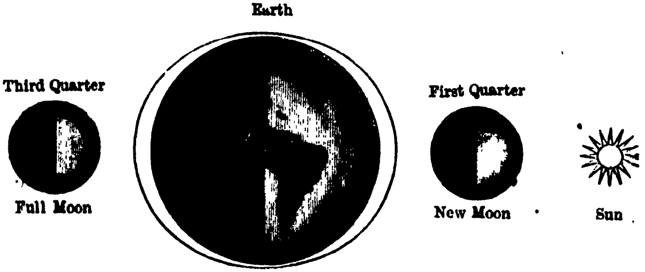
an-a-tom'-ic-al con-struc'-tion: the way in which the framework of an animal is put together.
ad'-ver-sa-ry: foe; enemy.
lim'-pid: clear; that can be seen through.
mam'-mal: an animal that suckles its young.
pro-pul'-sion: the being driven through the water.
ran'-cour: ill-will; spite; malice.
R.N.: Royal Navy.

13. TIDES. (I.)

Tides are caused by the mutual attraction of the earth and the moon, and in a less degree by the mutual attraction of the earth and the sun. Though the moon is so very small when compared with the sun, yet she is so close to the earth that she exerts far more influence upon the waters of the ocean than the sun does. The operation of these forces upon the water may be observed daily on our own shores. When the moon is directly over the ocean, she draws its waters into a long bank, stretching north and south, and rising to a height of about five feet, the summit of the bank being almost under the moon, thus causing **high water**, or **high tide**.

As the moon is on the meridian of any given point on the earth's surface only once in twenty-four hours, this explanation would account for only one tide during the day. But when the moon is directly causing a tide upon any part, there is a corresponding heaping up of the waters on the other side of the earth exactly opposite to it. This is due to the fact that the moon pulls the whole earth slightly towards itself and away from the waters on the side of the earth which is away from the moon. Hence the waters run together and form a second tidal wave on the other side of the earth. Thus there are two tides a day all over the world, for as the earth turns on its axis, every place upon its surface must come directly under the influence of the moon, and must also be farthest away from that direct influence, once in about twenty-four hours.

High and Low Tides.—This heaping up of the waters forms a long tidal wave. As this wave approaches an indented coast-line, such as that of Great Britain, the progress of the wave is impeded, and the water being confined into narrow channels rushes up the estuaries and bays seeking an outlet. Hence in such places the tide rises higher than in the open sea; the tide rises steadily for six hours, during which time it is said to flow, until **high tide** is reached. It then falls or **ebbs** for six hours until **low tide** is reached.

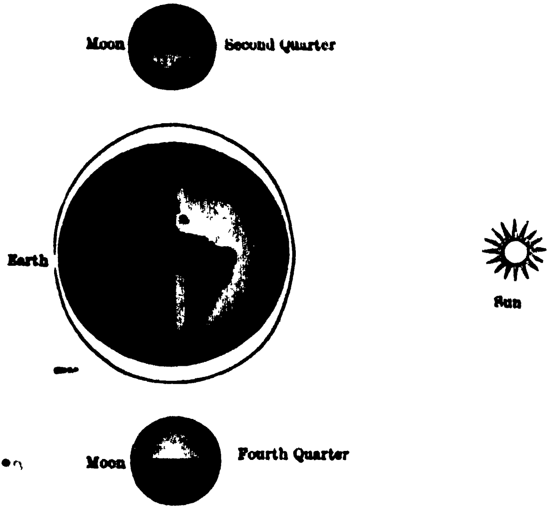


SUN AND MOON IN CONJUNCTION, NEAP TIDES.
The line drawn round the Earth shows, in a greatly enlarged form, the Tidal Wave.

The same thing happens during the next twelve hours or thereabouts, so that during a little over twenty-four hours high tide and low tide both occur twice.

Between the time of one high tide and another the moon has moved some distance in her orbit, and thus high tide is on an average about fifty minutes later on any one day than on the day before.

Spring and Neap Tides.—But it is noticed that regularly every fortnight the tides reach their greatest height.



SUN AND MOON IN OPPOSITION, NEAP TIDES.

Thus on a particular day it may be seen that at London Bridge the tide reaches a height, say, of nineteen feet, while on the same day in the following week it rises only eleven or twelve feet. How can this difference be accounted for? At the beginning of the lesson, it was stated that the sun helped to cause the tides. The fact is that the mutual attraction of the earth and the sun causes tides in exactly the same way that, as already shown, the mutual attraction of the earth and the moon does, though in a less degree.

At **new** and **full** moon, the moon and sun are in such a position towards the earth that they exert their influence together in drawing up the waters. This causes a very high tide which is followed by a very deep ebb. These are the highest kind of tides, and are called **spring tides.**

At half-moon, both waxing and waning, the influence of the sun is exerted at right angles to that of the moon, and the bodies are no longer acting together in pulling up the waters. The attraction of both sun and moon causes a tide, and the small tide caused by the sun lessens the larger tide caused by the moon. Hence the flood does not rise so high, nor does the ebb sink so low. These are called **neap** (or nipped) **tides.** As the moon takes a month to complete her revolution round the earth, it follows that both spring and neap tides occur twice a month. It must be remembered that high tide does not take place at the exact time when the moon is over a given meridian, but the tide follows the moon, and in the open ocean high tide is about two hours later than the moon. Further, spring tides do not occur at the exact time when the moon is full or new, neither do neap tides take place exactly at the quarters, but they are both about a day later.

at-trac′-tion: all the heavenly bodies have an attraction for each other, and each attracts everything on its surface.
in-dent′-ed: uneven; in and out.
sum′-mit: the highest part.
wan′-ing: growing smaller.
wax′-ing: growing larger.

14. TIDES. (II.)

The Tidal Wave.—It is in the Antarctic Ocean that we find an expanse of water encircling the globe, and it is there we must look if we wish to study the course of the great tidal waves. From this starting-point they flow to the northward and westward, progressing like any other great wave, in which the waters are not carried forward but only raised with an undulatory movement. But in the first place it must be remembered that, though the moon is constantly moving eastward, it appears to be moving towards the west. This is owing to the greater speed with which the earth rotates. Hence we shall find that the tidal wave moves towards the west, and in the Atlantic Ocean also towards the north.

The tidal wave which ultimately reaches our shores arrives at the Cape of Good Hope thirteen hours after it has left the coast of Tasmania, and thence rolls onward in fourteen or fifteen hours to the coasts of France, Spain, and Ireland. It penetrates into the North Sea by two different ways. One of its branches turns eastward round the north of Scotland and thence flows onwards to the south, taking from nineteen to twenty hours for the passage from the west of Ireland to the mouth of the Thames. A tide-wave, for instance, which appears at five in the afternoon on the west coast of Ireland, arrives at eight near the Shetland Islands, reaches Aberdeen at midnight, Hull at five in the morning, and Margate at noon.

The other branch of the same tide-wave, taking the shorter route through the English Channel, had meanwhile preceded it by twelve hours, having reached Brest about five o'clock in the afternoon (at the same time that the northern branch appeared at Galway), Brighton at nine, and the mouth of the Thames at midnight. Thus, in the southern corner of the North Sea, two tide-waves unite that belong to successive floods. The meeting of these tides gives rise to higher tides than would otherwise take place, and by giving deep water to the Thames allows large ships to sail up that river and considerably adds to the usefulness of London as a seaport.

It must be remembered that in narrow and confined seas and in estuaries the tidal wave not only rises and falls, but it actually flows strongly as a current, carrying the waters along at a rate of as much as five or six miles an hour. This current is so strong that sailing vessels have considerable difficulty in moving against it, and sailors carefully watch the tide so as to get as much help as possible from its moving waters.

Height of the Tides.—Were the whole earth covered with one sea of equal depth, the tides would regularly move onwards from east to west and everywhere attain the same height under the same latitude. But the direction and force of the tide-wave are modified by many obstacles on its way, such as coast-lines and groups of islands, and it has to traverse seas of very unequal depth and form. Flat shores impede its current by friction, while it rolls faster along steep, rocky coasts. In mid-Pacific the tidal wave only rises to a height of from three to five feet, and in the open Atlantic it does not exceed ten feet.

The effect of a shallowing sea-bed is to retard the progress of the tidal wave, so that the advancing waters overtake those in front and cause them to be heaped up. The shallow bank upon which the British Islands lie thus serves to increase the height of the tidal wave as it advances to our shores. Hence we find that in the Bristol Channel the tide reaches a height of fifty feet, while in the English Channel, which is open at both ends, it only rises about thirteen feet. The highest tides take place in the Bay of Fundy in North America, and here there is a difference between high and low water of from fifty to seventy feet.

The difference in the height of spring and neap tides is also very marked in some places. Thus in Milford Haven during neap tides there is a difference between high and low water of about fourteen feet, whereas at spring tides the difference is as much as twenty-five feet. The height of the tides in the harbours round the coast depends very much upon the direction and strength of the wind. Thus it has been observed on the coasts of Cornwall and Devon that when the barometer falls an inch (a sign of wind) the level of the sea rises a foot higher than would otherwise have been the case.

It has been commonly stated that, as the Mediterranean is so small a body of water as compared with the oceans, it has no tides. But this is not correct, for, though the tidal wave is almost imperceptible in the western parts, it rises on the eastern shores to a height of over a foot.

A Tidal Bore.—Sometimes the tide in rushing up an estuary is impeded by rocks and a rapidly shallowin shore. The water then becomes heaped up, and rushe up the river in the form of a high wave. This wave i called a **bore**, and makes its way up the Severn as a wal of water nine feet high. In some of the Asiatic river the bore reaches a great height, and is very destructive t the river banks and causes great danger to the shipping Thus in the Hooghly the bore advances as a wave twenty five feet high. But it is in the Tsien Tang in Chin that the greatest bore is found. Here the bore takes th form of a swiftly moving mass of water thirty feet i height and stretching from shore to shore as it advance up the river.

'Loud shouting from the fleet announced the appearance of the flood, which seemed like a glistening whit cable stretched athwart the river at its mouth, as fa down as the eye could reach. Its noise, compared b Chinese poets to that of thunder, speedily drowned tha of the boatmen; and as it advanced with great rapidity, it assumed the appearance of an alabaster wall, o rather of a cataract four or five miles across, and about thirty feet high, moving bodily onward! Soon it reached the advanced guard of the immense assemblage o vessels awaiting its approach. As the foaming wall o water dashed furiously onward, the boatmen were silenced, all being intently occupied in keeping their prows towards the wave, which threatened to submerge everything afloat; but they all vaulted, as it were, to the summit with perfect safety.

'The spectacle was of greatest interest when the bore had passed about half way among the craft. On one side they were quietly reposing on the surface of the unruffled stream, while those on the lower portion were pitching and heaving on the flood; others were scaling, with the agility of salmon, the formidable cascade.'

al′-a-bas-ter: a semi-transparent kind of gypsum or sulphate of lime.
Bay of Fundy: between Nova Scotia and New Brunswick.
ba-ro′-me-ter: an instrument for measuring the pressure of the atmosphere.
Hoogh′-ly: the mouth of the Ganges navigable for ships.
pre-ced′-ed: went before.
vault′-ed: leaped.

15. THE TREASURES OF THE DEEP.

WHAT hidest thou in thy treasure-caves and cells,
Thou hollow-sounding and mysterious main?
—Pale glistening pearls and rainbow-coloured shells,
Bright things which gleam unrecked of, and in vain.
—Keep, keep thy riches, melancholy sea!
We ask not such from thee.

Yet more, the depths have more! What wealth untold
Far down, and shining through their stillness lies!
Thou hast the starry gems, the burning gold,
Won from ten thousand royal argosies.
—Sweep o'er thy spoils, thou wild and wrathful main!
Earth claims not these again!

Yet more! the billows and the depths have more!
High hearts and brave are gathered to thy breast.
They hear not now the booming waters roar,
The battle-thunders will not break their rest.
—Keep thy red gold and gems, thou stormy grave—
Give back the true and brave.

Give back the lost and lovely! those for whom
The place was kept at board and hearth so long,
The prayer went up through midnight's breathless
gloom,
And the vain yearning woke 'midst festal song!
Hold fast thy buried isles, thy towers o'erthrown,—
But all is not thine own!

To thee the love of woman hath gone down,
Dark flow thy tides o'er manhood's noble head,
O'er youth's bright locks and beauty's flowery crown
—Yet must thou hear a voice—Restore the dead!
Earth shall reclaim her precious things from thee—
Restore the dead, thou sea!

MRS. HEMANS.

16. THE INHABITANTS OF THE SEA: CETACEANS. (II.)

THE NARWHAL.

The narwhal, or **unicorn-fish**, attains a length of from twenty to twenty-five feet. He is of a grey-white colour, punctured with many white spots, and, as his head is not disproportionate to the length of his body, may rank among the handsomest cetaceans. He distinguishes himself from all other members of the family by the long twisted tooth or horn projecting horizontally from the upper jaw. This mighty weapon, the true use of which can only be guessed at, was formerly sold at a very high price as proceeding from the fabulous unicorn. At present it is only paid for according to the worth of its excellent ivory, which is harder, heavier, and less liable to turn yellow than that of the elephant. The whalers are therefore highly delighted when they can pick up a chance narwhal, but this only happens in narrow bays, for the unicorn is an excellent swimmer, and extremely watchful. Scoresby found in the stomach of a narwhal remains of cuttlefishes, which seem to form his chief food, besides pieces of skates and plaice. The narwhal is common in the North Atlantic Ocean, but is never found in the Pacific.

The **dolphin** tribe is distinguished from the cachalot by a more proportionate head, and from the narwhal by the absence of the long horn. The most famous member of this numerous family is undoubtedly the classical dolphin of the ancients, which attains a length of from nine to ten feet. Troops of dolphins often accompany for days the track of a ship, and agreeably interrupt the monotony of a long sea voyage.

The **porpoise**, which only attains a length of five or six feet, and seems to be the smallest of all cetaceans, is frequently confounded with the dolphin. It is at home in the whole of the Northern Atlantic and also in the Mediterranean Sea. While the dolphin prefers the high seas, the porpoise loves tranquil bays and cliff-sheltered shores, and often swims up the rivers driving before him shoals of herrings and sprats. The porpoise is a no less excellent swimmer than the dolphin, making at least fifteen miles an hour. His rapidity and sharp teeth render him a most dangerous enemy to all the lesser fry of the ocean, whose sole refuge lies in the shallowest waters. When he rises to the surface to draw breath, the back only appears, and the head and tail are kept under water. At the entrance of harbours, where he is frequently seen gambolling, his leaping movements, now rising with a grunt, now sinking to reappear again at some distance, afford an entertaining spectacle.

A much more formidable animal, the largest of the whole dolphin tribe, is the ravenous **grampus**, which measures no less than twenty-five feet in length, and twelve or thirteen feet in girth. The upper part of the body is black, the lower white. Its ordinary food is the seal and some species of flat-fish, but it also frequently gives chase to the porpoise, and perhaps the whale would consider the grampus as his most formidable enemy were it not for the persecutions of man.

The **turtle** belongs to quite another class than the cetaceans, as it is one of the few remaining kinds of a once numerous family—namely, the reptile. The anatomy of the turtle offers many points of interest; its vertebræ, ribs, and breastbone growing together so as to form a bony envelope round the whole animal. This harness is covered by the skin, which in its turn is bedecked with large scales, while all the muscles and other soft parts are enclosed in the inner cavity. Only the head, feet, and tail protrude through openings between the upper and under carapace; and these can, by the land tortoises at least, be withdrawn entirely under the former. This is the only protection which Nature has afforded these animals against their enemies, for they have neither swiftness of flight nor any offensive weapon at their command. But as soon as anything suspicious approaches they conceal themselves under their massive cover, and oppose to every attack by tooth or nail the passive resistance of an impenetrable shield.

The turtles are distinguished from the land tortoises particularly by their large and long fin-shaped feet, and also by a longer tail, which serves them as a rudder. They have no teeth, but the horny upper jaw closes over the lower like the lid of a box, thus serving them as excellent shears either for crushing shells or dividing the tough fibres of the sea-grass. The flesh of the green turtle is everywhere esteemed as a first-rate delicacy, and its eggs are richly flavoured. Some kinds of turtle weigh over 800 lbs., and lay from twelve to twenty dozen eggs. No wonder that the mariner tired of salt beef and dried peas persecutes them on all the coasts of the tropical seas, wherever solitude, a flat beach, and a favourable season promise to reward his trouble.

ca′-ra-pace: shield or covering.
fab′-u-lous: spoken of in fables or tales; not founded on fact.
hor-i-zon′-tal-ly: parallel with the horizon; the opposite of vertical.
punc′-tur-ed: marked out with small holes.
ver′-te-bræ: the column of small bones that guards the spinal cord.

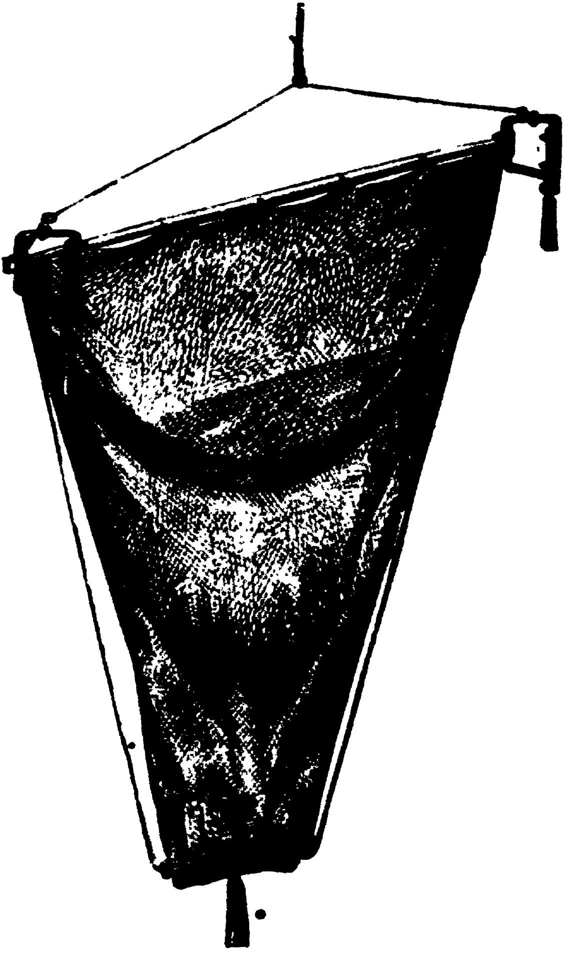
17. THE ATLANTIC OCEAN. (I.)

The Atlantic Ocean lies between the Old and the New World. It is a long irregular valley filled with water, and has a very broken coast-line, consisting of the shores of Europe and Africa on the eastern side and those of America on the western. Of these coasts the most indented are the shores of Europe, where large seas such as the Mediterranean and the Baltic are joined to the main ocean by narrow channels. Stretching from the Arctic Circle in the north to the Antarctic Circle in the south, its waters are spread over an extent of 10,000 miles. Its width varies from 800 miles between Greenland and Norway to 1,500 miles between Brazil and Sierra Leone, while at its widest part, between Florida and the coast of Africa, it measures 3,600 miles. It covers a total extent of about 40,000,000 square miles, and is therefore larger than the Old World.

Shape of the Ocean Bed.—Though there are many vast patches in the floor of the Atlantic of which we know so little that we cannot make a correct map, still, generally speaking, so many soundings have been taken that we are able to understand the general form of the bottom of the ocean valley. This is especially true as regards the floor of the North Atlantic, which has been often explored with a view of finding the best course to take in laying telegraph-cables. In addition to the information gained in this way, various expeditions have been sent out for the purpose of making scientific researches, and the deep-sea soundings taken by them have greatly added to our knowledge. From them we learn that from the west coast of Europe a large submarine plain forms the floor of the ocean for several hundreds of miles. From this plain rise the masses of land which are called the British Islands. These islands are of irregular shape and have an extremely rugged coast-line in the west, where for ages the wild waves of the ocean have beaten upon the rocky shores, eating out the soft places and leaving the hard rocks standing out in the most fantastic forms. They are separated from the mainland by two bodies of water, the North Sea and the English Channel, each of which is extremely shallow, and a depth of more than 300 feet is rarely met with.

This submarine plain extends to the west for a distance of about 200 miles, when there is a rapid descent to a depth of about 2,000 fathoms. From this depth the ocean bed stretches out to the west as a vast undulating plain, crossed by many a range of hills and furrowed with many a valley, until it reaches a point about 300 miles from the coast of Newfoundland, where the bed gradually rises again in a long slope to the shores of North America. This great plain has a width of a thousand miles and an average depth of about 10,000 feet—that is to say, a rope two miles in length if let down from the surface would reach the bottom in most places. It has been called the 'telegraph plateau' because its formation is so well adapted for the purpose of laying the cables, and because it has been crossed in several places by these wonderful ties which literally join the Old World to the New.

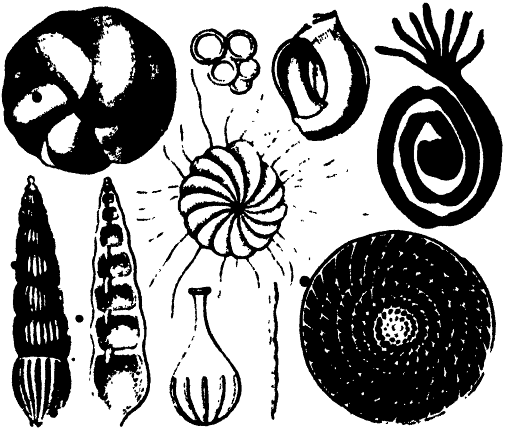
Dredging.—But not only have we learned the shape of the bed of the ocean, but we have already found out a



DEEP SEA TRAWL AS USED ON THE 'CHALLENGER.'

great deal about what lies on this vast floor. This knowledge has been acquired by the use of dredges which have been lowered from ships, and, after having been dragged for some distance along the bottom, have been hauled up and their contents examined. The expedition which threw most light upon the bed of the ocean was that of the ship 'Challenger,' which sailed from England in December 1872 and returned in June 1876. This ship was specially fitted for the purpose, and carried a number of men who were skilled in various branches of science. The deep-sea trawl used almost constantly in the latter part of the voyage consisted of a conical bag twenty feet long, with one side suspended by six strong straps to a beam of very hard wood from sixteen to twenty feet in length. The other side of the mouth of the bag hung loose, and was weighted with close-set rolls of thick sheet lead to drag along the bottom. Two iron runners like the runners of a sledge were fixed one at either end of the beam, and were made so heavy that as the trawl was lowered the beam went down with its side to which the runners were attached facing the ground. Hence the net was stretched out above and behind the beam as the trawl was dragged slowly over the ocean floor.

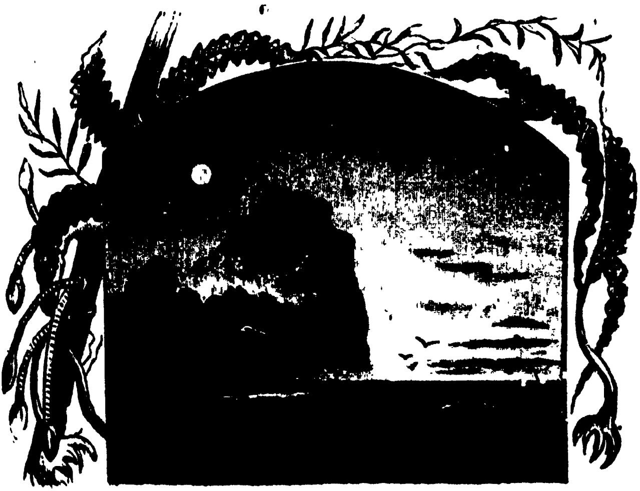
Nature of the Bottom.—From these dredgings it has been found that the whole of the ocean bed to a depth of about 2,000 fathoms is covered with a fine greyish mud called **ooze.** This consists of myriads of small bodies that are the skeletons of animals of a very simple kind called Foraminifera, which exist in countless numbers in the ocean at a depth of only a few fathoms from the surface. Here they live and here they die, and their shells fall in an unceasing shower to the bed of the ocean. In this way the floor is covered with layers of varying thickness of a calcareous deposit very much like chalk. In addition to the Foraminifera, which form the bulk, there is also a quantity of mineral matter consisting of fragments of pumice and particles of many minerals due to the breaking up of volcanic rocks. At a depth of more than 2,000 fathoms, the carbonate of lime of these shells is changed by the action of other chemicals in the sea water. The mineral matter assumes a larger proportion in relation to the lime of the shells; and the ooze becomes gradually darker, until at length it gives place to a red clay.



FORAMINIFERA (*magnified*).

In this way the bed of the ocean is being gradually but surely filled up, and, though it may take millions and millions of years for this mighty work to have an appreciable effect on the size of the oceans, yet as surely as the chalk hills of England are composed of countless myriads of skeletons of small animals, so in time will the ocean floor be covered with a deposit of chalk hundreds of feet thick. In studying these subjects we must remember that the Creator does not measure His work by years, for 'a thousand years in His sight are but as a single day.'

cal-car'-e-ous: like or containing chalk and lime.
pum'-ice: a hard, light, and spongy mineral thrown out by volcanoes.
sub'-ma-rine: under the sea.



18. THE ATLANTIC OCEAN. (II.)

The waters of the ocean are never still. Even on the calmest day, when the water is perfectly smooth to all outward appearance, movements are all the while going on, and these movements are caused in various ways. One cause of motion in the water is the unequal heating in different places. Where the water is shallow it rapidly becomes warm under the fierce rays of the sun. As it warms it expands, and therefore requires more room. Hence it begins to move, and, as hot water is lighter than cold water, it flows over, as it were. Beneath it colder water also moves towards the shallow places. In this way a constant interchange is kept up between the waters of different parts of the sea.

Another cause of motion in the water is the difference in the degree of saltness. The more salt water contains the heavier it is. In parts of the ocean where the sun is very hot, evaporation is very rapid. As the surface water is turned into vapour, it leaves its salt behind it. This salt mixes with the layer of water immediately below, and increases its density so much that it becomes too heavy for the water beneath to hold it up, and therefore begins to fall. This, therefore, is another way in which a movement is produced.

The winds also cause movement in the waters. Sometimes they blow the surface water into high heaps and ridges called waves. In places where winds blow constantly in one direction over large areas of water, they produce a steady movement of the water in the same direction as they blow. Such movements are called currents.

From these and other causes there is a constant interchange going on between the waters of different parts of the ocean.

One of the greatest movements in the ocean is that of a constant drift of the cold water of the Antarctic Ocean towards the Tropics. In the South Atlantic Ocean this drift advances along the surface to nearly the latitude of South Africa, when it meets with water so much warmer, and therefore of less density than itself, that it gradually sinks and continues on its way to the Tropics at varying distances beneath the surface.

From about the neighbourhood where this Antarctic drift disappears, another current begins, which flows northward for some distance along the west coast of Africa until it turns to the west and crosses the Atlantic just south of the Equator. This is called the **Equatorial Current**, and is one of a system of currents which are constantly moving towards the west all round the world in the neighbourhood of the Equator. On nearing the shores of Brazil, this current splits into two branches. One branch flows southwards under the name of the **Brazil Current**, and, eventually turning to the east, completes the circuit of the South Atlantic. The other branch flows through the Caribbean Sea into the Gulf of Mexico. Here it becomes highly heated, and, after flowing round the Gulf, it issues from the western outlet to the South of Florida as the far-famed **Gulf Stream**.

This stream or current flows northwards along the shores of America for some distance, and then, turning to the east, it crosses the Atlantic. As it nears the shores of Western Europe it splits up into several parts, one of which skirts the northern coast of Africa, and then, being seized hold of by the north-east trade wind, it is swept into the Equatorial Current again, and so makes the tour of the North Atlantic.

Not only is there a movement of the cold waters of the Antarctic Ocean towards the Tropics, but there is also a drift or creep of the waters of the Arctic Ocean to the south. That which flows through Davis Strait is the best known because of the numerous expeditions that have sailed through it to discover the north-west passage to India and in fruitless efforts to reach the Pole, as well as from the constant presence in summer of whalers in these seas. The strength of this current may be seen from the fact that in the summer of 1857 the 'Fox,' which was hemmed in by ice, drifted southwards for a distance of nearly 1,200 geographical miles. Even far north, where the surface of the sea is completely covered with icefields and icebergs, the current is sufficiently strong to carry these floating masses far into the Atlantic, where the increasing warmth of the water and heat of the sun gradually melt them, and where they are a constant source of danger to passing ships. They often come so far to the south that steamships meet with them on their way from England to New York, and the ships of one famous line take a longer southerly course to avoid the danger. This **Arctic Current** also sinks as it nears warmer regions, and gradually creeps near the bed of the ocean towards the Equator, where, becoming warmed, it rises to the surface in its turn, and flows northwards again.

Hence we see that there is a constant movement going on of hot surface-waters from the equatorial regions to the north and south, and of cold water in the opposite direction. Further, that there are ascending and descending movements of the water due to differences in saltness and temperature, and also currents that move round and round the whole extent of both the North and South Atlantic Oceans.

Neither does this exhaust the kinds of movement; for the sun is ever drawing up immense volumes of water in the form of vapour, which in its turn becomes condensed and falls as rain upon sea and land, from the latter of which it is drained by rivers into the oceans, and so the circulation is completed.

Flo'-ri-da: a peninsula and state in the south of the United States.

geographical mile: or a knot, 2,028 yards.

19. THE GULF STREAM.

It is about four hundred years ago since Columbus began to be persuaded that there must be a large extent of land across the Atlantic to the west. Spanish and other ships had sailed along the north-western coasts of Africa, and had ventured as far as the islands of the Azores, where sailors had seen stranded on the shores bamboos of an enormous size, pieces of wood that had been carved by human hands, trunks of trees, and fruits and seeds unknown in the Old World. These objects had been carried across the Atlantic by means of a powerful current which we now call the **Gulf Stream.**

It has already been explained how the Equatorial Current pours its stream into the confined Gulf of Mexico, where the waters are in a manner heaped up and forced out again in the opposite direction with great force, and so a strong current is caused. This water has been raised to a high temperature, and issues from the Strait of Florida as a broad belt of warm water. It flows to the northward in a direction nearly parallel to the coast of America until it reaches the neighbourhood of about 40° N. lat., when it bends to the east and crosses the Atlantic, widening as it flows onward, and gradually becoming shallower until it loses its distinctive character and becomes split up into numerous branches.

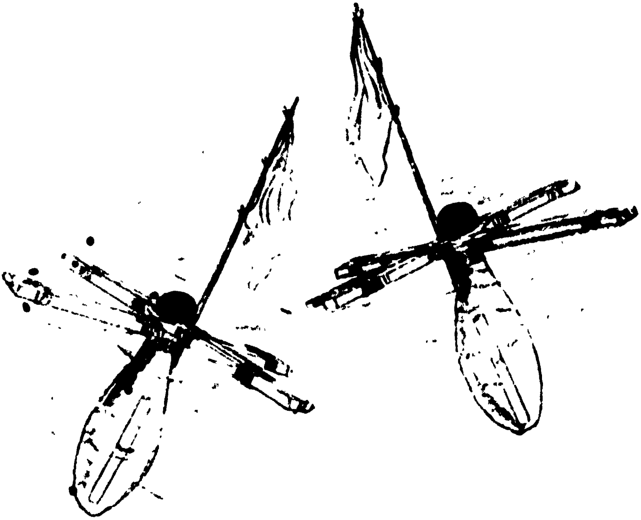
One of these branches bends to the south, and, after skirting the north-western shores of Africa for some distance, it is seized hold of by the north-east trade wind, which carries it on in its course and sweeps it into the Equatorial Current. So it again crosses the Atlantic, and Humboldt states that some casks of palm oil which formed part of the cargo of an English ship wrecked off Cape Lopez in Africa were found upon the coast of Scotland, and must therefore twice have crossed the Atlantic.

The northern branches of the Gulf Stream diffuse warm water over parts of the North Atlantic, and are said to bring warmth to the shores of the British Islands and Norway. Certain it is that the climate of these countries is much warmer than other parts of the world in the same latitude, and in Norway it is a striking fact that while the harbours and openings are always free from ice, the Baltic Sea is completely frozen up all the winter.

When the Gulf Stream issues from the Strait of Florida it has a temperature of upwards of 80° Fahr., and a velocity of about five miles an hour. When it is passing between the United States and the Bermudas its temperature is still 70°, while that of the water over which it flows is only from 35° to 40°. In this part of its course it is about seventy miles in width. As it crosses the Atlantic it parts with its heat very slowly, and even when off the shores of Western Europe its water is warmer than that of the seas in corresponding latitudes in other parts of the world.

Though the Gulf Stream plays so important a part in the North Atlantic it is extremely shallow. From the 'Challenger' reports it is seen that whereas between the

United States and the Bermudas the depth of the ocean is about 2,000 fathoms, the depth of the Gulf Stream is only about 100 fathoms. Here it flows along, a wide river of deep blue water, carrying with it in its course seaweeds, flying-fish, and numerous kinds of animal life



GULF STREAM BOTTLES.

which, trusting to its tepid waters, accompany it into latitudes that would otherwise be fatal to them.

Off the coasts of Newfoundland the Gulf Stream is met by the Arctic Current, which flows southward bringing with it masses of floating ice. Its temperature is very low, and on meeting the warm water the cold water gradually sinks below and continues its southerly course, while the warm water, being much lighter, easily floats over it, and continues on its course to the east. The meeting of two such large moving bodies of water having such different degrees of temperature is the cause of the dense fogs and mists which prevail over the famous 'banks' of Newfoundland.

According to Humboldt's calculations, a boat left to the current, and moving along without any other assistance, would require about thirteen months to float from the Canary Islands to the Caribbean Sea as far as Caracas. From Caracas to the Straits of Florida it would take another ten months on the way, and would then require about a year to carry it across the North Atlantic to the Canary Islands again. Much useful knowledge of the direction and force of this as well as of other currents has been learned from the Gulf Stream Bottles. These contain a record of date and place of being first thrown into the sea, with a request that any captain picking them up will add date and place and return them into the sea again. Observations made in this way are reported, and by careful comparisons much has been learned of the velocity and directions of currents.

bam-boo': a very large and tall grass with a jointed stem; used for all kinds of purposes in tropical regions.

Co-lum'-bus: a famous navigator who discovered America.

Car-ac'-as: a port in Venezuela.

tep'-id: slightly warm.

20. THE INHABITANTS OF THE SEA: SEA-COWS, SEALS, AND SEA-BEARS.

THE **manatees** of the Atlantic Ocean and the now nearly extinct **dugongs** of the Indian Seas form the connecting link between the real whales and the seals and walruses. Like the whales, these animals have no hind-feet, but they have a very powerful tail, which is their chief instrument of locomotion. When they raise themselves with the front part of their body out of the water, a lively fancy might easily be led to imagine that a human shape, though certainly none of the most beautiful, was surging from the deep. They live at peace with all other animals, and seem to be solely intent upon satisfying their voracious appetite. Like the hippopotamus, they swallow large masses of sea-plants or of juicy grasses growing beyond the water's edge on the borders of rivers. The manatees, or sea-cows, inhabit the coasts and streams of the Atlantic along the north-eastern shores of South America, and attain a length of from eight to ten feet. The flesh is capital meat, and has a flavour somewhat like that of ham.

FEMALE DUGONG OF CEYLON.

The **seal** family forms a still nearer approach to the land quadrupeds, as here hind-feet begin to make their appearance. The shortness of these extremities renders their movements upon land generally awkward and slow, but they make up for this deficiency by an uncommon activity in the water. Their body, tapering fish-like from the shoulders to the tail, their abundance of fat, the lightness of which is so favourable to swimming, the position of their feet, admirably formed for rowing, paddling, and steering, all fit them for the sea. Although citizens of two worlds, their real element is evidently the water, from which their food is exclusively derived.

Seals are found in almost all seas, but they particularly abound on the coasts of the colder regions of the earth, and diminish in size and number as they approach the torrid zone. The giants of the family, the sea-lions and the sea-bears, belong exclusively to those higher latitudes which the sun visits only with slanting rays, or where the winter forms a dreary and continuous night.

There is no doubt that, owing to cruel and indiscriminate slaughter of the young, seals have diminished in numbers, and places which were formerly favourite hunting-grounds are almost deserted.

When the seals observe a boat, they endeavour to escape before it reaches the ice; the sailors, however, raise a long-continued shout, which frequently causes the amazed animals to delay their retreat until arrested by blows. When seals are abundant, the boat immediately pushes off after the slaughter is finished, and proceeds to another piece of ice, leaving one man to flay off the skins and fat. But in situations where boats cannot navigate,

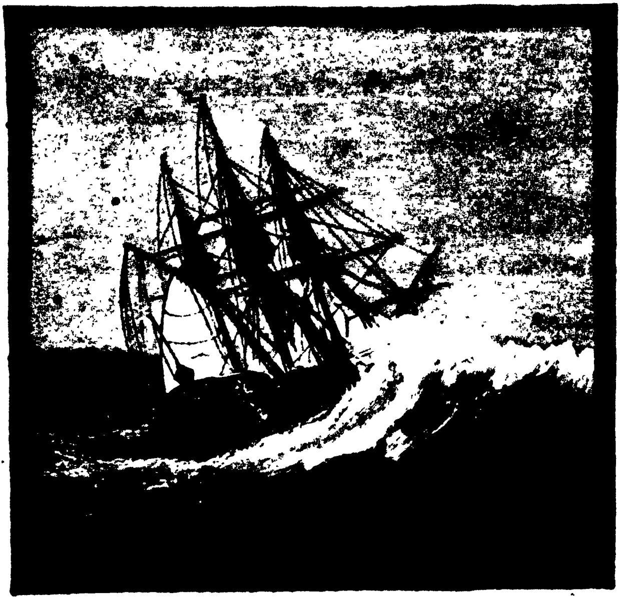
AUSTRALIAN SEA-BEARS

the seal fishers have to pursue them over the ice, leaping from piece to piece until the capture is made. Every man then flenses his own, and drags the skins and blubber to his boat or ship.

The most important and valuable of all is the **sea-bear**, which is found in great abundance upon the islands in Behring Sea, their favourite haunt being the island of St. Paul. From October 5, St. Paul is gradually deserted by the sea-bears, which then migrate to the south and reappear towards the end of April. The males arrive first. Each seeks the same spot on the shore which he occupied during the preceding year, and lies down among the large stone blocks with which the flat beach is covered. About the middle of May the far more numerous females begin to make their appearance.

The full-grown sea-bear is from eight to nine feet long, measures five feet in girth, and acquires a weight of from eight to nine hundred pounds. He owes his name to his shaggy blackish fur, and not to his disposition, which is far from being cruel or savage. The young are generally lively, fond of play and fight. When one of them has thrown another down, the father approaches with a growl, caresses the victor, tries to overturn him, and shows increasing fondness the better he defends himself. The male is very much attached to the females, but treats them with all the severity of an Oriental despot. When a mother neglects to carry away her young, and allows it to be taken, she is made to feel his anger. He seizes her with his teeth, and strikes her several times, not over gently, against a rock. As soon as she recovers from the stunning effects of these blows, she approaches her lord in the most humble attitudes, crawls to his feet and, as some writers tell us, even sheds tears. Meanwhile the male crawls about to and fro, gnashes his teeth, rolls his eyes, and throws his head from side to side. But when he sees that his young is irrevocably lost, he then, like the mother, begins to cry so bitterly that the tears trickle down upon his breast.

car-ess'-es: fondles.
flen'-ses: a word applied to cutting the fat or blubber from a whale or seal.
hip-po-pot'-a-mus: a large herb-eating animal found in the African rivers.
in-dis-cri'-min-ate: without picking or choosing.
ir-re'-vo-cab-ly: without hope of recovery.
Oriental despot: an Eastern king with the powers of a tyrant.
pre-ced'-ing: going before.



JAMAICA.

21. SOME ISLANDS OF THE ATLANTIC.

Jamaica.—'Our first view of Jamaica impressed us greatly; and no wonder, for we were gazing on the celebrated Blue Mountains, which deserve all the epithets of admiration that have ever been bestowed on them. Rising from a richly cultivated plain, principally of sugar-cane, we could revel in the light and shade and colour of their sides and low peaks, intersected by fertile valleys; while their summits, between 7,000 and

8,000 feet high, were hidden in masses of floating clouds and wreaths of driving mists. About two o'clock we observed an immense wall of black cloud advancing swiftly behind us—evidently a heavy squall of rain, driven before a strong wind. It was grand to see the storm-cloud rushing on, hiding the sun and lashing the waves into fury, while the peculiar hoarse roar of a tropical wind was heard in the rigging.

'The first view of Port Royal, of which we had not heard very encouraging accounts, agreeably surprised us, and we really thought it extremely pretty as seen by the evening light. On the other hand, we were somewhat disappointed to find that all the tempting hooks, pieces of pork, and other bait which we had hung out from the stern as we approached the land, failed to induce a single specimen of the traditionally celebrated Port Royal sharks to pay us a visit.

'Our first impressions of Kingston, which were fully confirmed by subsequent experience, were that it is the most desolate collection of tumble-down wooden houses, with rickety verandahs leaning over rotten stone pavements, and broken-down steps leading to streets full of holes and ruts, that we ever saw. Kingston has, like Port Royal, the original capital of the island, been very unfortunate in the way of conflagrations, having been partially destroyed on four separate occasions.'

A Drive in Jamaica.—'The vegetation, watered from so many sources, was, as may be imagined, of extraordinary luxuriance, even for this land of profusion It was impossible, in the course of our rapid drive, to ascertain with precision the nature of the verdure; but we could recognise masses of delicate ferns, shading each pool and rill, and themselves overhung by glorious tree-ferns, their graceful feathery crowns poised on stems thirty or forty feet high. From among the ferns rose the giant stems of the silk-cotton trees, their buttress-like roots looking weird and wild indeed in the moonlight. Every crevice in the cliffs seemed to be filled with creepers; while grand rope-like lianes, richly covered with orchids, swung gently in the cool night breeze from the tops of the rocks or from the branches of the tallest trees. Lower down the wild fig grew from tree to tree; or, climbing and twisting round one alone, embraced it so tightly that it seemed as if it would in all probability shortly kill the object of its too close attentions. The variety of scenic effects was endless. Sometimes the rocks so nearly met over our heads that the branches of the trees above, closely interlaced and bound still more tightly by twining plants, formed a thick roof quite impervious to every ray of light. Now and again it seemed as if we were about to plunge into a bottomless abyss. Then we would emerge into a more open part of the gully, where the bright rays of the now fully risen moon penetrated freely, casting the blackest and weirdest of shadows among the fantastically shaped rocks and the abrupt and deeply cut precipices, full of hollows and caves and grottoes, and transforming—so it seemed to our quickened fancy—the spurs of the silk-cotton tree into huge beams and props, and the great lianes into boa-constrictors and pythons, hanging by their tails to the branches of the trees, in readiness to spring across our path and to envelope us in their deadly toils.'

The Bermudas.—'Approaching the islands from the southward, their general effect is somewhat sombre. The land is low, rising nowhere to a height greater than 260 feet, and by far the greater part forming gentle undulations at a height of from twenty to sixty feet above the sea-level. The island is a coral atoll, and the water all round it is remarkably deep. The climate is very genial and the people are largely employed in growing potatoes, tomatoes, and onions for the New York markets. It is a naval and military station, and contains the largest floating dock in the world.'

VIEW AT PORT ANTONIO: JAMAICA.

The Azores.—These islands consist of three groups, but the largest and most important of them all is San Miguel. The climate is mild and equable. They are all volcanic, and the rocks which slope steeply to the sea are lava streams of different dates. The soil has been made by the wearing down of the volcanic rocks, and is very fertile. Hence we find that a rich vegetation abounds and the cultivation of the orange is the chief industry in San Miguel, where the fruit attains its greatest perfection. The oranges begin to ripen early in November, and from that time to the beginning of May a constant succession of fast ships conveys them to the London market.

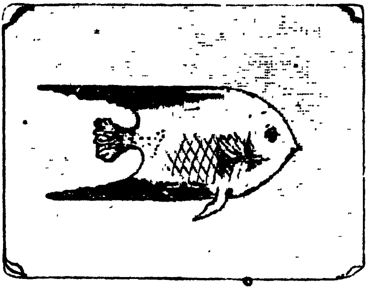
The Falkland Islands.—These islands are about a hundred in number, but only two of them are of any size. The climate is very miserable, and fog and rain are so constant and sunshine so scarce that wheat will not ripen, and barley and oats never become fully ripe. Of late years sheep-rearing has become popular, and the wool produced is of the finest quality. Ships going round the south of America call here for fresh stores.

con-fla-gra′-tion : fire.
e′-pi-thets : names or words expressing certain qualities.
grot′-toes : small caves or hollows.
Kingston : the capital of Jamaica.
la′-va : the melted rock which is thrown out of volcanoes.
li′-an-es : tropical creepers.
Port Royal : a seaport in Jamaica; the old capital.

22. THE WONDERS OF THE SEA ON A CORAL-BANK IN THE BAHAMAS.

On this same coral reef we had our first peep through the 'magic glasses,' as I think I may fairly call them; and you cannot imagine the world of utterly unexpected wonders that were at once revealed to us. What a fairy scene it was! How clearly we could see the lovely submarine garden; and how short a distance it seemed to be beneath us! How we longed to do what appeared to be perfectly easy—to step down into the crystal depths and walk about at our leisure: to admire, if not to pluck, the many enchanting things growing there. There were sponges of all kinds and shapes: great round masses of sheep's wool and velvet sponges, of a yellowish brown colour, and bright scarlet glove-sponges branching up like huge hands. Their brilliant colour was derived from the sponge-making animal which still adhered to them; for they were soon washed snow-white over the side of the boat. Then there were little black balls of reef-sponges, covered with the black bodies of their manufacturers, forming a sort of shiny coat, which made them look anything but suitable for use as face-sponges. There were wire-sponges, the colour of which is also due to the animals by which they are constructed; and grey sponges sometimes called Venus's cups—in shape not unlike coral Neptune's cups. Very often the latter grow together in a group on a coral base, and resemble a set of wine-glasses, on stems.

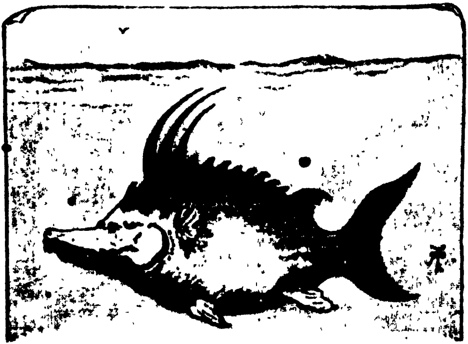
These sponges were scattered among corals, or clung to rocks, with graceful seaweeds growing on them. The brain-coral, so called from its resemblance to the convolutions of the human brain, is specially fine here. One specimen which I secured surpassed in beauty of form and delicacy of structure anything of the kind I had ever imagined. Having observed it through the sponge-glass, I pointed it out to the diver, who promptly reduced his already very scanty garments to a minimum, seized a hatchet, jumped overboard, and sank easily to the bottom, holding on by one toe to something or another to keep him down until he had detached the coral from its native rock. He could not, however, succeed in bringing the coral to the surface: it was too heavy for him. A stirrup of rope was therefore made; and with the assistance of the other diver my precious treasure was placed in the boat.



ANGEL-FISH.

Besides the splendid brain-corals, there were others of every sort and description, resembling mushrooms, purple and yellow fans, stars and trees, and many other objects. Among them grew sponges, madrepores, seaweeds of the most varied forms and delicate hues, and sea-anemones of every kind and colour; while above the beautiful purple and yellow fan-corals—the latter of which I had never seen before—waved the plumes of the graceful pink and mauve sea-feathers, which, as seen through the translucent waves, looked almost more like ferns than feathers. Each coral, it must be remembered, instead of being one of those dry bleached skeletons with which we are all familiar in collections, and which, beautiful in form as they often are, sadly want colour and life, had bright little feathered tentacles, stretched out from every aperture, waving backwards and forwards in search of its tiny prey.

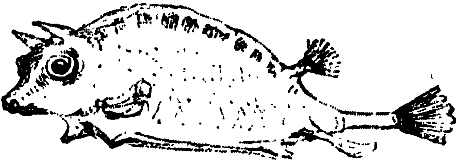
The brightest coloured fish, looking like tropical birds and butterflies, shot about in every direction. I really did not know which to admire most among them. The humming-bird fish, all blazing in purple and gold, is supposed to surpass all others in beauty; but there is a bright blue fish, like a brilliant Brazilian butterfly, which runs him very close. The black and orange Spanish angel-fish were especially gorgeous; the little paler-yellow variety looked graceful and gay as canary-birds, as they flitted about in shoals; while the more sober but equally handsome dark-coloured blue and green fish claimed a special share of admiration.



HOG-FISH.

I am not at all sure that the velvet-fish, the skin of which really looked just like jet-black velvet of the richest pile, with three bright orange spots on each side of its face, was not one of the handsomest. Among the larger specimens were the black and white striped gropers, supposed to be the best fish for the table in the West Indies; the striped blue and white pilot-fish, the presence of which is almost always a sure sign that one or many sharks are not far off; and many others too numerous to mention: while quantities of shells, which I have no attempted to describe, were also plainly visible.

If you can picture to yourself the most beautiful o corals, madrepores, seaweeds, sea-anemones, sea-lilies, and other fascinating marine objects, growing and flourishing under the sea, with fish darting about among them like the most gorgeous birds and butterflies conceivable, all in the clearest water, which does not impede the vision in the least, and resting on a bottom of the smoothest white coral sand; if you still further imagine a magnificent blue sky overhead, and a bright sun shining out of it; even then you will have but a very faint idea of the marvellous beauty of the wonders of the sea on a coral bank in the Bahamas.



COW-FISH.

> And here were coral bowers,
> And grots of madrepores,
> And banks of sponge, as soft and fair to eye
> As mossy bed whereon the wood-nymphs lie,
> With languid limbs, in summer's sultry hours.
> Here, too, were living flowers. . . .

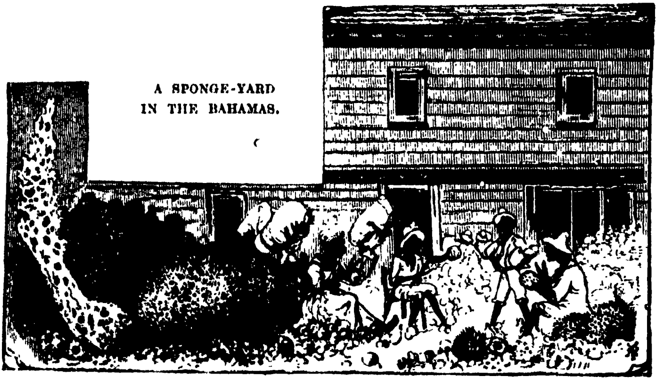
From Lady Brassey's 'In the Trades, the Tropics, and the Roaring Forties.'

a-nem'-o-ne: a small animal, beautifully coloured, and resembling a flower when open; fastens itself to the rocks.
con-vo-lu'-tions: twistings or folds.
magic glasses: glasses so made that objects can be seen at considerable depths under water.
mad'-re-pore: a small but beautiful sea-animal.
trans-lu'-cent: beautifully clear; that can be seen through.

23. A VISIT TO A SPONGE-YARD.

ONE's first inclination on entering the yard was to remark, 'Oh my, what a lot of sponges!' There were sponges everywhere; 'sponges in front of us; sponges to right of us, sponges to left of us'; sponges enough, of every variety, quality, size, and shape, to please the fancy and meet the washing requirements of the whole world; all lying piled up in great heaps about the wharf. There were warehouses full of sponges that were still unsorted, and great bins full of those that were sorted. Many men—mostly negroes—were busily occupied in clipping, cutting, and separating the different varieties. Some men have a speciality for the last-named branch of the occupation, and divide 'sheep's wool' and 'velvet, or any other kind, into qualities first, second, or third with the greatest possible dexterity, clipping out the bad parts, throwing the sponges into the various baskets, and diminishing the large pile from which they are sorting in a marvellously short space of time.

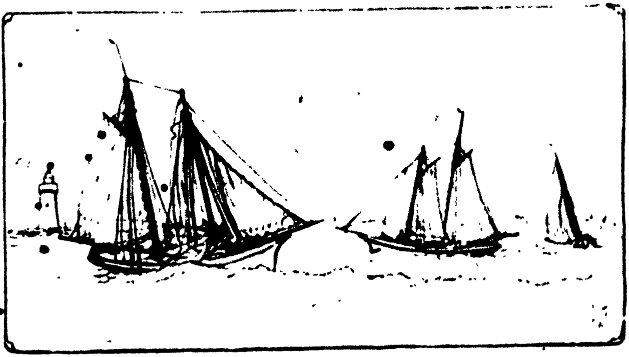
The Bahama sponges, which, for the purposes of commerce, are divided into eight sorts, though excellent in quality, are not so good as those of the Mediterranean; but, I believe, a scheme has now been devised for taking cuttings of the best species of Mediterranean sponges, transplanting them to these waters, and grafting them on to the existing roots. The experiment has, however, not been very extensively tried at present. Formerly the best sponges were found off the islands of Abaco and Andros—especially the former—but within the last two years a very fine bed of 'sheep's wool' sponges has been discovered near the island of Eleuthera, though they lie in such deep water that they cannot be got at without dredging. It unfortunately happens that a few years ago the American fishermen were supposed to interfere with our trade, and to seriously injure the young sponges, by dredging over the Bahama banks. A law was consequently passed that no dredging should be allowed in these waters under any circumstances whatever; so that now the colonists are sorely perplexed as to how to get at the beautiful sponges which they have discovered, it being impossible for a diver to procure them from a depth of between sixty and seventy fathoms.



A SPONGE-YARD IN THE BAHAMAS.

The value of the sponges exported in 1882 and 1883 was 60,000*l*. The American consul at Nassau, in a recent official report, states that 'the sponge trade gives employment to several thousands of persons and some hundreds of vessels, the sponges being divided into coarse and fine, of which the former bring about 5 dollars per cwt., and the latter double that sum. The principal varieties, in the order of their value, are known as sheep's wool, white reef, abaco velvet, dark reef, boat, hardhead, grass, yellow, and glove; and of some of these varieties there are several grades designated by numbers, all being used for mechanical, surgical, and bathing purposes.

The boats employed in sponging are small, with crews of from six to twelve men. About six weeks' provisions are taken on board, and the vessels then coast along the banks and reefs, where the water is shallow and generally so clear that the sponges are readily seen. They are brought to the surface by hooked poles, or sometimes by diving. When first drawn from the water they are covered with a soft gelatinous substance as black as tar and full of organic life; the sponge, as we know, being only the skeleton of the organism. The day's catch is spread out on the deck, so as to kill the mass of animal life, which, in expiring, emits a most unpleasant



SPONGE SCHOONERS.

odour. Then the spongers go ashore and build a pen, or "crawl," of stakes, close to the water's edge, so that the action of the tide may wash away the black covering; the process being aided by pounding the sponges with sticks. As soon as this operation is completed, the sponges are strung upon small palmetto strips, three or four to a strip, which is called a "bead"; after which they are taken to Nassau to be sold in the sponge market, under certain conditions and regulations: nobody being allowed to sell his cargo otherwise than through this sponge-exchange. On the conclusion of the sale the sponges are taken to the packing-yard, where they are sorted, clipped, soaked in tubs of lime-water, and spread out to dry in the sun. They are then pressed by machinery into bales, containing 100 lbs. each, and in this state are shipped to England or the United States, the latter of which countries has become of late years almost the largest consumer of Bahama sponges.'—*From Lady Brassey's 'In the Trades, the Tropics, and the Roaring Forties.'*

Abaco, Andros, Eleuthera: islands of the Bahamas.
de′-sig-na-ted: named or called.
dex-ter′-i-ty: skill.
ge-lat′-in-ous: like gelatine; anything soft, pulpy, and sticky.
Nassau: the chief town of the Bahamas.
palm-et′-to: the name given to various fan-palms.

24. SIR HUMPHREY GILBERT.

SOUTHWARD with fleet of ice
  Sailed the corsair death;
Wild and fast blew the blast,
  And the east wind was his breath.

His lordly ships of ice
Glistened in the sun,
On each side like pennons wide
Flashing crystal streamlets run.

His sails of white sea-mist
Dripped with a silver rain,
But where passed there were cast
Leaden shadows o'er the main.

Eastward from Campobello
Sir Humphrey Gilbert sailed,
Three days or more eastward he bore,
Then alas! the land-wind failed.

Alas! the land-wind failed,
And ice-cold grew the night,
And never more on sea or shore
Should Sir Humphrey see the light.

He sat upon the deck,
The book was in his hand,
'Do not fear! heaven is as near,'
He said, 'by water as by land.'

In the first watch of the night,
Without a signal's sound,
Out of the sea mysteriously
The fleet of death rose all around.

The moon and the evening star
Were hanging in the shrouds.
Every mast as it passed
Seemed to rake the passing clouds.

They grappled with their prize
  At midnight black and cold,
As of a rock was the shock,
  Heavily the ground-swell rolled.

Southward through day and dark,
  They drift in close embrace,
With mist and rain to the Spanish Main,
  Yet there seems no change of place.

Southward, for ever southward,
  They drift through dark and day,
And like a dream in the Gulf Stream
  Sinking vanish all away.

LONGFELLOW.

cor'-sair: a rover; a pirate.

Spanish Main: the sea off the coasts of South America was commonly spoken of as the Spanish Main.

Sir Humphrey Gilbert was born at Dartmouth in 1539 A.D. He was half-brother to Sir Walter Raleigh. In his second voyage to America he took possession of Newfoundland, but was drowned on his return voyage.

25. THE FIRST VOYAGE ROUND THE WORLD.

Six years after Balboa had first seen the Pacific, Ferdinand of Magellan made his appearance in that great ocean. His plan of seeking a new road to India across the Atlantic being but coldly received in his native country, he transferred his services to Spain. With five ships, the largest of which did not carry more than 120 tons, and with a crew of 236 men, partly the sweepings of the gaols, he sailed on September 20, 1519, and spent the following summer (the winter of the southern hemisphere) on the dreary coast of Patagonia. In this uncomfortable station he lost one of his squadron; and the Spaniards suffered so much from the excessive rigour of the climate, that the crews of three of his ships, headed by their officers, rose in open mutiny, and insisted on relinquishing the visionary project of a desperate adventurer, and returning directly to Spain. This dangerous insurrection Magellan suppressed by an effort of courage no less prompt than intrepid, and inflicted exemplary punishment on the ringleaders.

He now continued his journey to the south, and reached, near 53° S. lat., the celebrated straits which bear his name. Here again he had to exert his full authority to induce his reluctant followers to accompany him into the unknown channel that was to lead them to an equally unknown ocean. One of his ships immediately deserted him and returned to Europe, but the others remained true to their commander, and, after having spent twenty days in winding through those dangerous straits, they at last, on November 27, 1521, emerged into the open ocean, the sight of which amply repaid Magellan for all the anxieties and troubles he had undergone. They now pursued their way across the wide expanse of waters, of whose enormous extent they had no conception, and soon had to endure all the miseries of hunger and disease. But the continuous beauty of the weather and the steady easterly wind, which, swelling the sails of Magellan, drove him straight onwards to the goal, kept up his courage, and induced him to give to the ocean which greeted him with such a friendly welcome the name of the Pacific, which it still, though undeservedly, retains.

STRAIT OF MAGELLAN.

During three months and twenty days he sailed to the north-west, and, by a singular mischance, without seeing any land in those isle-teeming seas, except only two uninhabited rocks. At last, after the longest journey ever made by man through the deserts of the ocean, he discovered the small but fruitful group of the Ladrones (March 6, 1521), which afforded him refreshments in such abundance, that the vigour and health of his emaciated crew were soon re-established. From these isles, to which his gratitude might have given a more friendly name, he proceeded on his voyage, and soon made the more important discovery of the islands now known as the *Philippines*. In one of these he got into an unfortunate quarrel with the natives, who attacked him in great numbers and well-armed; and, while he fought at the head of his men with his usual valour, he fell by the hands of those barbarians, together with several of his principal officers.

Thus Magellan lost the glory of accomplishing the first circumnavigation of the globe; the performance of which now fell to the share of his companion, Sebastian El Cano, who returned to San Lucar in the 'Victoria' by the Cape of Good Hope, having sailed round the globe in the space of three years and twenty-eight days.

But although Magellan did not live fully to achieve his glorious undertaking, the astonishing perseverance and ability with which he performed the chief and most difficult part of his arduous task have secured him an immortal renown. Nor has posterity been unmindful of his services, having awarded his name an imperishable place in the memory of man, both in the straits, the portal of his grand discovery, and in the 'Magellanic clouds,' those dense clusters of stars and nebulæ which so beautifully stud the firmament of the southern hemisphere.—*From Hartwig's 'The Sea and its Living Wonders.'*

Balboa: one of the first Spanish captains to visit the West Indies. He established a colony in Panama, and 'from a peak in Darien' was the first European to behold the Pacific.
e-ma'-ci-a-ted: looking thin and ill through privation and disease.
in-trep'-id: fearless; daring.
Ladrones: a group of islands in the Pacific.
re-lin'-quish-ing: giving up.
re-luct'-ant: unwilling.
vis'-ion-ary: not real.

26. EARLY ENGLISH VOYAGES OF DISCOVERY.

In the year 1553 Sir Hugh Willoughby and Chancellor left England on their memorable voyage of Arctic discovery, and steered to the north-east. In a stormy night they parted company, never to meet again. For a long time nothing was heard of Willoughby, until some Russian sailors found on the dreary coast of Lapland two wrecks tenanted only by the dead. A note, dated January 1554, proved that then at least some of the unfortunate navigators were still alive; but this was the last and only memorial of the mysterious end of the first Britons that ever ventured into the frozen seas.

Chancellor was more fortunate. After having for a long time been driven about by storms, he discovered the White Sea, and on landing heard for the first time of Russia and her sovereign the Czar, who resided in a great town called Moscow. This unknown prince the brave seaman resolved to visit in his capital, where he was graciously received, and obtained permission for his countrymen to frequent the port of Archangel. Soon after his return to England he was sent back to Russia by Queen Mary, for the purpose of settling the terms of a treaty of commerce between the two nations; and, having satisfactorily accomplished his mission, once more set sail from the White Sea, accompanied by a Muscovite ambassador. But this time the return voyage was extremely unfortunate; two of the ships, richly laden with Russian commodities, ran ashore on the coast of Norway, and Chancellor's own vessel was driven by a dreadful storm as far as Pitsligo in Scotland, in which bay it was wrecked. Chancellor endeavoured to save the ambassador and himself in a boat, but the small pinnace was upset, and, although the Russian reached the strand, the Englishman, after having escaped so many dangers in the Arctic Ocean, was doomed to an untimely end within sight of his native shores.

Twenty years afterwards, Martin Frobisher set sail with three small vessels of thirty-five, thirty, and ten tons, on no less an errand than the discovery of a north-west passage to Asia. With these wretched nutshells he reached the coasts of Greenland and Labrador, but was prevented by the ice from effecting a landing.

This first voyage was little remarkable in itself, but its accidental results tended much to the advancement of northern research, for Frobisher brought home some glittering stones, the lustre of which was erroneously attributed to gold; a circumstance which, as may well be imagined, greatly contributed to pave the way for a second expedition. This time Frobisher sailed with three ships, of a much larger size, that they might be able to hold more of the anticipated treasure; and, besides securing 200 tons of the imaginary gold, discovered the entrance of the strait which bears his name.

His geographical knowledge may be inferred from the fact that he firmly believed the land on one side of this channel to be Asia, and on the other America; and, though we may be tempted to smile at his ignorance, yet the lion-hearted seaman is not the less to be admired, who with such inadequate means ventured to brave the unknown terrors of the Frozen Ocean.

The gales and floating ice which greeted Frobisher as he endeavoured to force a passage through the strait put a stop to all farther progress to India; but, as the gold delusion still continued, the expedition was considered eminently successful. A large squadron of fifteen vessels was consequently fitted out for the summer of 1578, and commissioned not only to bring back an untold amount of treasure, but also to take out materials and men to establish a colony on those desolate shores.

But this grand expedition, which sailed forth with such extravagant hopes, was doomed to end in disappointment. One of the largest vessels was crushed by an iceberg at the entrance of the strait, and the others were so beaten about by storms and obstructed by fogs that the whole summer elapsed, and they were fain to return to England without having done anything for the advancement of geographical knowledge.

The utter worthlessness of the glittering stones having meanwhile been discovered, Frobisher relinquished all further attempts to push his fortunes in the northern regions, and sought new laurels in a sunnier clime. He accompanied Drake to the West Indies, commanded subsequently one of the largest vessels opposed to the Spanish Armada, and ended his heroic life while attacking a small French fort on behalf of Henry IV., during the war with the League. He was one of those adventurous spirits always thirsting for action, and too uneasy ever to enjoy repose.

In the year 1585, John Davis, with the ships 'Sunshine' and 'Moonshine,' carrying besides their more necessary equipments a band of music 'to cheer and recreate the spirits of the natives,' made his first voyage in quest of the north-west passage, and discovered the broad strait which leads into the icy deserts of Baffin's Bay. But neither in this attempt nor in his two following ones was he able to effect the object for which he strove; and these repeated failures cooled for a long time the national ardour for northern discovery.—*From Hartwig's 'The Sea and its Living Wonders.'*

am-bas'-sa-dor: a Minister of high rank sent by one sovereign to another.

Mus'-cov-ite: a Russian.

War with the League: the League was a combination of Catholics to stamp out the Huguenots or Protestants from France; its chief opponent was Henry IV. of France, to whom the English lent aid until he joined the Romish Church.

27. THE PACIFIC OCEAN. (I.)

A REMARKABLE feature in the Pacific Ocean, and one that distinguishes it from every other sea, is the immense assemblage of small islands with which it is crowded, particularly in the portion situated between the Tropics. For about 3,000 miles from the coast of South America the sea is almost entirely free from islands, but thence to the great isles of Malaysia an immense belt of ocean, nearly 5,000 miles in length, and 1,500 in breadth, is so studded with them as almost to be one continuous archipelago.

The term **Polynesia**, by which this division of the globe is now distinguished, is compounded of two Greek words meaning *many islands.* Very few of these gems of the ocean are more than a few miles in extent, though Tahiti and some in the more western groups are of rather larger dimensions; while Hawaii—the largest island in Polynesia—is about the size of Yorkshire.

The isles which in such vast numbers thus stud the bosom of the Pacific are of three distinct forms—the coral, the crystal, and the volcanic. Of these the first formation greatly predominates, but the largest islands are of the last description; of the crystal formation but few specimens are known. Imagine a belt of land in the wide ocean not more than half a mile in breadth, but extending in an irregular curve to the length of ten or twenty miles or more, the height above the water not more than a yard or two at most, but clothed with a mass of the richest and most verdant vegetation.

Here and there above the general bed of luxuriant foliage rises a grove of cocoa-nut trees, waving their feathery plumes high in the air and gracefully bending their tall and slender stems to the breathing of the pleasant trade-wind. The grove is bordered by a narrow beach on each side, of the most glittering whiteness, contrasting with the beautiful azure waters by which it is environed.

From end to end of the curved isle stretches in a straight line—forming, as it were, the cord of the bow—a narrow beach of the same snowy whiteness, almost level with the sea at the lowest tide, enclosing a semicircular space of water between it and the island, called the lagoon. Over this line of beach—which occupies the leeward side, the curved being to windward—the sea is breaking with sublime majesty.

The long unbroken swell of the ocean, hitherto unbridled through a course of thousands of miles, is met by this rampart, when the huge billows, rearing themselves high above its level and bending their foaming crests 'form a graceful liquid arch, glittering in the rays of a tropical sun as if studded with brilliants. But before the eyes of the spectator can follow the splendid aqueous gallery which they appear to have reared, with loud and hollow roar they fall in magnificent desolation, and spread the gigantic fabric in froth and spray upon the horizontal and gently broken surface.'

Contrasting strongly with the tumult and confusion of the hoary billows without, the water within the lagoon exhibits the serene placidity of a mill-pond. Extending downward to a depth varying from a few feet to fifty fathoms, the waters possess the lively green hue common to soundings on a white or yellow ground, while the surface, unruffled by a wave, reflects with accurate distinctness the mast of the canoe that sleeps upon its bosom, and the tufts of the cocoa-nut plumes that rise from the beach above it. Such is a coral island; and if its appearance is one of singular loveliness, as all who have seen it testify, its structure on examination is found to be no less interesting and wonderful.

The beach of white sand which opposes the whole force of the ocean is found to be the summit of a rock which rises abruptly from an unknown depth like a perpendicular wall. The whole of this rampart, as far as our senses can take cognisance of it, is composed of living coral; and the same substance forms the foundation of the curved and more elevated side, which is smiling in the luxuriance and beauty of tropical vegetation. The elevation of the coral to the surface is not always abruptly perpendicular; sometimes reefs of varying depths extend to a considerable distance in the form of successive platforms or terraces.

In these regions may be seen islands in every stage of their formation, 'some presenting little more than a point or summit of a branching coralline pyramid, at a depth scarcely discernible through the transparent waters; others spreading like submarine gardens or shrubberies beneath the surface, or presenting here and there a little bank of broken coral and sand, over which the rolling wave occasionally breaks;' while others exist in the more advanced state I have just described, the main bank sufficiently elevated to be permanently protected from the waves and already clothed with verdure, and the lagoon enclosed by the narrow bulwark of the coral reef.

Though the rampart thus reared is sufficient to preserve the inner waters in a peaceful and mirror-like calmness, it must not be supposed that all access to them from the sea is excluded. It almost invariably happens that in the line of reef one or more openings occur, which, though sometimes narrow and intricate, so as scarcely to allow the passage of a native canoe, are not unfrequently of sufficient width and depth to permit the free ingress of large ships.

The advantage to man of these openings is very great. Without them the islands might smile invitingly but in vain; no access could be obtained to them by shipping through the tremendous surf by which their shores are lashed; but by these entrances the lovely lagoons are converted into the most quiet, safe, and commodious havens imaginable, where ships may lie and wood and water and refresh their crews in security, though the tempest howl without.

P. H. Gosse.

ar-chi-pel'-a-go: a sea studded with islands.
en-vi'-ron-ed: enclosed or surrounded.
lag-oon': a shallow lake of salt or brackish water.
plac-id'-i-ty: calmness; peacefulness.
pre-dom'-in-ates: outweighs or exceeds all others in number.

28. THE PACIFIC OCEAN. (II.)

The Pacific Ocean alone covers more than half the surface of the globe. And yet it is not quite four hundred years since the inhabitants of Europe first learned of its existence. What must have been the feelings of Balboa when guided by friendly natives, he reached a spot in Central America from which he saw stretched out before him another ocean

Magellan named it the 'Pacific' as, after battling with the fierce storms that ever beat about Cape Horn, he sailed his ship into the peaceful waters of the ocean. What wondrous tales the early navigators brought home of new and delicious fruits, of strange men, and of coral islands set in summer seas. Even now Cook's 'Voyages' are to us full of the charm of adventure and the surprise of ever finding something new.

The Pacific covers an area of about ninety millions of square miles, and is, therefore, nearly twice as large as the whole of the land area of the globe. It lies between the shores of America on the east and those of Asia on the west, and stretches from the Arctic to the Antarctic Circle. At its northern extremity, where Asia and America nearly meet, it is only about forty miles broad, but between the coasts of California and China its width is about 8,500 miles, while its length as measured from the confines of the two frigid zones is about 10,000 miles.

Very little is known of the bed of the Pacific, but soundings have shown that its average depth is nearly the same as that of the Atlantic; that the elevation of the ocean floor varies in different parts, but on the whole it consists of plateaux, mountain peaks, deep valleys, and plains. Further, in many places the floor is gradually sinking, and, were it not for the constant work of the coral animals, many an island would long ago have sunk beneath the waves.

The bed is covered with ooze just as the floor of the Atlantic is. Being broader and to a certain extent broken up by islands, its tides do not rise so high, neither are its currents so strong, as those of the Atlantic. It has but few large inland seas connected with it, and receives the drainage of but few large rivers. This is strikingly so on the east coast, where there is not a single river of the largest class.

Currents.—The currents of the Pacific are not so clearly defined, neither are they as well-known as those of the Atlantic. In the far south there is a constant drift of the cold waters of the Antarctic Seas towards the north. These drifts combine and form a steady current, which flows along the western coast of South America under the name of the **Peruvian** or **Humboldt's Current.** It brings with it icebergs and masses of floating ice, and is several degrees colder than the waters of the surrounding ocean. It is owing to the presence of this cold current that Chili and Peru have so cold a climate for the latitude. Thus Callao, which is situated only 12° south of the Equator, has a much colder climate than Rio Janeiro, which is in 23° S. lat. This current carries its cold waters even to the Equator, where it is still so cold that reef-forming coral animals cannot live in it. Here it bends to the west and is merged in the **Equatorial Current.**

This current flows across the Pacific from east to west. Its course is much broken by the thousands of islands among which its waters slowly move, and on nearing the shores of Asia it becomes broken up into many branches. Of these the most important is the

Japan Current or **Kuro Siwo**, which flows northward along the coasts of Japan, and then, bending to the east, crosses the North Pacific and is swept again into the waters of the Equatorial Current.

The Japan Current plays the same part, though not so important a one, as does the Gulf Stream, for it carries warm water to the eastern shores of Asia. But its waters are not so warm, and, having to cross a wider ocean, its influence is not nearly so well-marked as that of the Gulf Stream.

Winds.—In the Pacific Ocean as in the Atlantic, the **north-east trade winds** and the **south-east trade winds** blow on either side of the Equator, but the trade winds of this ocean are not so strong, neither do they blow so constantly and steadily, as those in the Atlantic Ocean. This is partly due to the presence of a vast number of islands, among which the winds become to a certain extent broken up. The character of the trade winds is that of a constant soft breeze, strongest in the morning, weaker at noon, and again increasing towards evening. Cyclones and tornadoes are common in the China Sea.

Cyclones and Tornadoes are winds which rotate rapidly round a centre, while at the same time the whole cyclone is carried onward at a great speed.

nav′-ig-a-tor: a sailor.

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29. THE ANCIENT MARINER IN THE TROPICS.

The sun now rose upon the right;
Out of the sea came he
Still hid in mist,—and on the left
Went down into the sea.

The fair breeze blew, the white foam flew,
The furrow follow'd free;
We were the first that ever burst
Into that silent sea.

Down dropt the breeze, the sails dropt down,
'Twas sad as sad could be;
And we did speak only to break
The silence of the sea.

All in a hot and copper sky,
The bloody sun, at noon,
Right up above the mast did stand,
No bigger than the moon.

Day after day, day after day,
We stuck, nor breath nor motion;
As idle as a painted ship
Upon a painted ocean.

Water, water, everywhere,
And all the boards did shrink;
Water, water, everywhere,
Nor any drop to drink.

And every tongue, through utter drought,
Was wither'd at the root;
We could not speak, no more than if
We had been choked with soot.

S. T. Coleridge.

80. CORAL ANIMALS.

IN a previous lesson we described in a general way the coral islands of the Pacific. We will now try and see what kind of an animal it is that works such wonders. We have read of islands which are inhabited by man being raised from the ocean by this mighty creature, And yet it is no giant that with mighty heave has brought these islands from the deep. It is the work of one of the smallest of animals, working in myriads, quietly but steadily, for ages.

The coral animal resembles in form the common China aster which grows in our gardens. It has the same central disc and the same coloured petals, but in the coral animal the petals are feelers or tentacles which the animal can move at will. And there we see at once a striking difference between one of the lowest forms of animal life and a plant. For whereas in the latter the petals are merely extended to the air and sunlight, the feelers of the animal can be moved so as to grasp the food which may come in their way.

Each little creature is provided with a strong tube which contains his stomach and mouth, and fits into the orifice which he inhabits. Unable to move from his position, he goes on steadily forming a sort of calcareous deposit, and at his death leaves his own skeleton to add to the beautiful and imperishable structure which his ancestors have been raising for so many thousands of years. They increase very much like vegetables, commencing in the form of little buds, and gradually attaining maturity, when they either take the place of their parents or drop off and find an independent home.

Very often they have other modes of multiplication. Thus, a coral polype may give off small buds, each of which grows into a perfect animal, with its own stomach, mouth, and feelers, but remains closely connected with the parent. In other cases the coral animal spontaneously splits into two halves, and these in turn may divide and subdivide, the product of each division growing into a perfect polype. By frequent repetitions of these processes of budding and splitting, the corals may form masses of great size. In fact, it is the growth of coral in this manner that forms those masses of land which are known as coral reefs and coral islands.

Such land is said to be 'built' by the coral animals; but it should be understood that it is not a constructive work such as the building of a nest, where the bird gathers the materials from far and near and weaves them together to make her home, but it is rather an accumulation of the calcareous remains, or skeletons, of the coral polypes.

Corals of some kinds live in all seas, but the particular kinds which grow in great masses, and thus form reefs and islands, are found only in the warmer parts of the earth. Reef-forming coral animals are only found in waters of which the mean temperature for the month, even in the coldest season, never falls below 68°. Such a belt of warm water never extends beyond 32° north and south of the Equator, and it is therefore in the seas which lie between these bounds that coral islands are found. Further, it is known that the coral animal never works at a depth greater than about twenty fathoms below the surface. But in places we find that the walls of coral go almost straight down for a thousand feet or more! The explanation of this is to be found in the fact that in the Pacific Ocean the floor is gradually subsiding. We know that changes in the elevation of parts of the earth's surface are constantly going on; some parts are being gradually raised and other parts are slowly falling.

Many of the islands of the Pacific are of volcanic origin, and around some of these peaks the coral animal first began to work, gradually bringing its wondrous structure to the surface. But the animal cannot work above high-water mark, and were it not for some other agency its work would here cease. But as it slowly pushed its work to the surface, the whole land upon which its building was raised was slowly subsiding; and so for ages the little worker has gone on, until the peak has disappeared and its place has been taken by masses of coral, while the first part that was raised has sunk hundreds of fathoms deep. The constant breaking of the surf against its outer wall has kept it steep to the sea.

In places the inner island or peak still stands above the surface of the ocean, and around it at varying distances may be seen an encircling or **barrier reef.** These barrier reefs are of all sizes, from three miles to no less than forty-four miles in diameter. The largest is the Greet Barrier Reef, which skirts the north-east coast of Australia for 1,200 miles, at an average distance of from twenty to thirty miles from the coast. The channel between this reef and the coast has a depth of about twenty-five fathoms, while outside the depth of the sea suddenly increases to many hundreds of fathoms. 'Usually a snow-white line of great breakers, with

CORAL: FROM THE 'CHALLENGER REPORTS.'

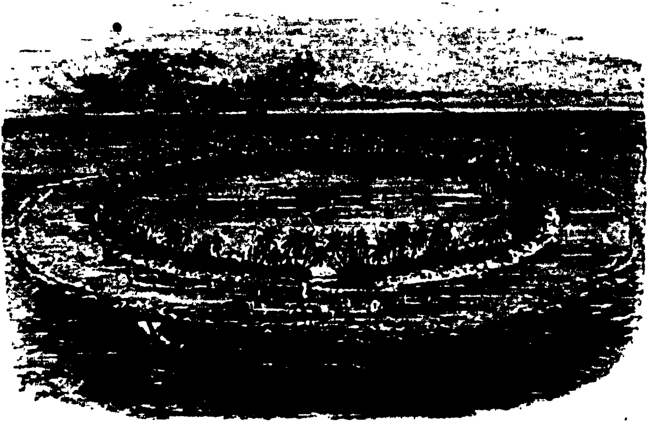
only here and there a single low islet crowned with cocoa-nut trees, divides the dark heaving waters of the ocean from the light-green expanse of the lagoon channel. And the quiet waters of this channel generally bathe a fringe of low alluvial soil, loaded with the most beautiful productions of the Tropics, and lying at the foot of the wild, abrupt, central mountains.'

ac-cu-mu-la'-tion: a heaping up into a mass.
al-lu'-vi-al: soil deposited by river or sea.
an'-ces-tors: forefathers.
cal-car'-e-ous: made of or pertaining to lime.
or'-i-fice: an opening made something like a mouth.
pol'-ype: an animal with many arms or feelers radiating from a centre.
sub-sid'-ing: slowly sinking or falling.

31. CORAL.

In tropical seas, and particularly in the Pacific Ocean, many of the islands are skirted by low banks of coral rock. At high tide these rocks are mostly under water, and their position is marked by a white line of heavy breakers. At low water the rocks appear just above the surface. Some islands are completely surrounded with these **fringing reefs** and others are only fringed at certain points. There is no essential difference between the fringing reefs and the barrier reefs except that the former have less width and islands are but rarely found upon them. As the corals grow most vigorously on the outside of the reef, this is the highest part, and between it and the beach there is generally a stretch of water only a few feet in depth.

In the previous lesson it was shown how by the gradual subsidence of the land there are many islands which are composed entirely of coral, though the coral has been built upon peaks which formerly stood high above the surface. These islands rise from the sea usually as a low strip of land more or less ring-shaped. Inside this rim of rocks there is a shallow lake or lagoon of clean green water. The outer rim of coral land is generally tufted with cocoa-nut palms. Entrance to the lagoon is obtained through gaps in the reef. These circular-shaped coral islands are called **atolls**, and are very abundant in both the Indian and Pacific Oceans.



AN ATOLL: CLARKE ISLAND.

The Maldive Islands and Laccadive Islands are entirely built of coral, and consist of a number of atolls lying near each other; they are well described by Mr. Darwin, who says: 'I cannot refrain from once again remarking on the singularity of these complex structures—a great sandy and generally concave disc rises abruptly from the unfathomable ocean, with its central expanse studded and its edge symmetrically bordered with oval basins of coral rock just lipping the surface of the sea, sometimes clothed with vegetation, and each containing a lake of clear water!'

Hence we see that the coral animals begin their mighty work in shallow water, from the bottom of which they slowly raise a mighty monument to the power of myriads of animals, no matter how small, when they are working towards the same end. We have seen how they raise a fringe of rocks round the islands. We have further seen that in places these fringes have been built around island peaks which have all the while been slowly sinking into the depths of the sea, and how as they sank the coral animals have built their barriers higher and higher and further and further inland as the island diminished in size. And at last, when the island disappeared beneath the waves, there yet remained the barrier of coral rock tufted all round with palms to mark the spot. In this way thousands of islands have been formed which are now lovely spots in the ocean.

But as the coral animals cannot work above high-water mark, it may well be asked how habitable islands can be formed upon their crests! The breakers which ceaselessly roll against the shores help to build them up, for they break off masses of the rock and throw them up high upon the reef and over into the lagoon within; thus gradually adding to the height as well as to the width of the outer rim. Corals and shells are crushed and ground to powder by the action of the waves, and this dust fills the interstices in the rocks and helps to give them a solid face. Plants and weeds wash upon the reef, and, decaying, leave a soil behind them. So the pile rises higher and higher. The waves wash up upon it drifting seeds and floating timber. Sea-birds make it their home, and by their deposits help to make a fertile soil. In time the feathery palm raises its head above the reef, and the sailor, seeing its waving plumes, marks in his chart the site of a new island.

At last, after vegetation has completed its work, man appears upon the scene, builds his hut on the fruitful soil which falling leaves and decaying plants have enriched, and calls himself the master of this little world.

We often express our astonishment at the power of the tornado as we read that it has passed over miles of land, levelling everything to the earth. We are struck with awe and terror at the gigantic forces of the earthquake which rends the earth in twain. But greater far than all these are the mighty forces which quietly and unnoticed are raising islands in the ocean, or lowering the ocean floor for thousands of square miles, or by means of myriads of minute animals are covering the bed of the sea with deposits of limestone hundreds of feet thick.

in-ter′-stic-es: narrow cracks or openings.
o′-val: of a circular shape, but with one diameter longer than the other.
sym-met′-ric-al-ly: of uniform shape; regular; even.
sub′-sid-ence: sinking.

32. THE CORAL GROVE.

Deep in the wave is a coral grove,
Where the purple mullet and gold-fish rove;
Where the sea-flower spreads its leaves of blue,
That never are wet with falling dew,
But in bright and changeful beauty shine
Far down in the green and glassy brine.

The floor is of sand, like the mountain-drift,
And the pearl-shells spangle the flinty snow;
From coral rocks the sea-plants lift
Their boughs where the tides and billows flow.

The water is calm and still below,
For the winds and waves are absent there,
And the sands are bright as the stars that glow
In the motionless fields of upper air.

There, with its waving blade of green,
The sea-flag streams through the silent water,
And the crimson leaf of the dulse is seen
To blush like a banner bathed in slaughter.

There, with a light and easy motion,
The fan-coral sweeps through the clear, deep sea,
And the yellow and scarlet tufts of ocean
Are bending like corn on the upland lea.

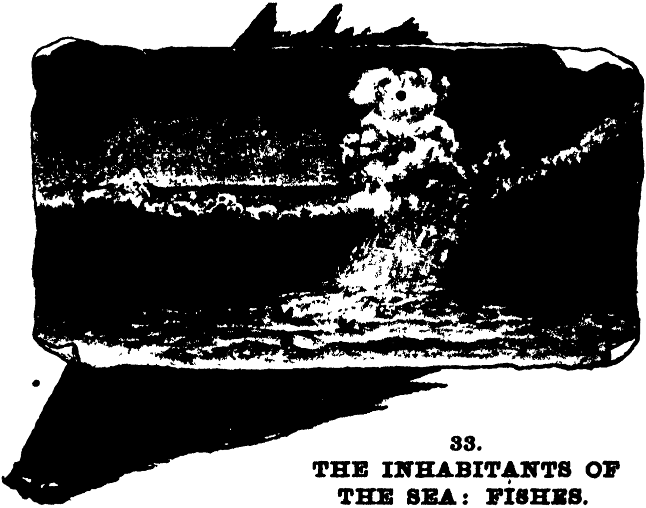
And life, in rare and beautiful forms,
Is sporting amid those bowers of stone,
And is safe when the wrathful spirit of storms
Has made the top of the wave his own.

And when the ship from his fury flies,
Where the myriad voices of Ocean roar,
When the Wind-god frowns in the murky skies,
And demons are waiting the wreck on shore,—

Then, far below, in the peaceful sea,
The purple mullet and gold-fish rove,
Where the waters murmur tranquilly
Through the bending twigs of the coral grove.

J. G. Percival.

dulse: a kind of seaweed.
fan coral: a beautiful kind of coral that spreads out arms like fans in the water.
mull'-et: a sea-fish, round in shape, and very good for eating.
tran'-quil-ly: peacefully; calmly.
tufts: small bunches.



33.

THE INHABITANTS OF THE SEA: FISHES.

Modern science has succeeded in describing and picturing over eight thousand different kinds of fishes; yet there can be no doubt, that many still unknown species dwell in the depths of the ocean, or in the distant seas which are but seldom visited by the European mariner.

In studying fish the mind is at once struck with the wonderful way in which the shape and build are adapted to a swift and easy movement through the water. Every part of the body seems specially adapted to produce speed. The fins, the tail, and the motion of the whole backbone assist progression; and it is to this admirable flexibility of body, which mocks the efforts of art to imitate it, that fishes owe the astonishing rapidity of their movements.

The life of fishes is a state of perpetual warfare, a constant alternation of flight and pursuit. Prowling through the waters, they attack and devour every weaker being they meet, or dart away to escape a similar lot. Many of them are provided with the most formidable weapons.

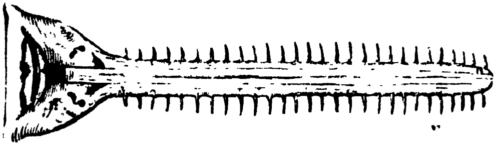
WOLF-FISH.

Thus the **sea-wolf** has six rows of grinders in each jaw, excellently adapted for bruising the crabs and whelks, which this voracious animal grinds to pieces and swallows along with the shells. When caught, it fastens with indiscriminate rage upon anything within its reach, fighting desperately, even when out of its own element, and inflicting severe wounds if not cautiously avoided. The great size of the monster, which in the British waters attains the length of six or seven feet, and in the colder and more extreme northern seas is said to become still larger, renders it one of the most formidable denizens of the deep.

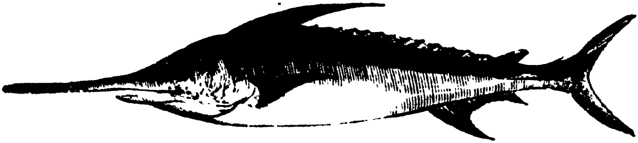
Far more dreadful, from its gigantic size and power, is the **white shark**, whose jaws are likewise furnished with from three to six rows of strong, flat, triangular, sharp-pointed, and finely serrated teeth, which it can raise or depress at pleasure. This tyrant of the seas grows to a length of thirty feet, and its prodigious strength may be judged of from the fact that a young shark, only six feet in length, is able to break a man's leg by a stroke of its tail. Thus, when a shark is caught with a baited hook at sea and drawn upon deck, the sailor's first act is to chop off its tail, to prevent the mischief otherwise to be apprehended from its enormous strength.

Fortunately for the inhabitants of the British Isles the white shark confines his range to tropical seas. But the **dog-fish** and several other species of our seas, such as the blue shark, though they do not attempt the fisherman's life, are extremely troublesome and injurious to him, by hovering about his boat and cutting the hooks from the lines in rapid succession. This, indeed, often leads to their own destruction, but when their teeth do not deliver them from their difficulty, the blue sharks which hover about the Cornish coast during the pilchard season have a singular method of proceeding. They roll their bodies round and round so as to turn the line about them throughout its whole length, and sometimes this is done in such a complicated manner that the fishermen give up any attempt to unroll it as a hopeless task. To the pilchard drift-net this shark is a still more dangerous enemy, as it is common for it to pass in succession along the whole length of net, cutting out, as with shears, the fish and the net that holds them, and swallowing both together.

The saw-snouted shark or **saw-fish**, which grows to fifteen feet in length, and the **sword-fish** are furnished with peculiarly formidable weapons. The long flat snout of the former is set with teeth on both sides through its whole length, while the upper jaw of the latter terminates in a long sword-shaped snout. A sword-fish, twenty feet in length, once ran his sword with such violence into the keel of an East Indiaman that it penetrated up to the root, and the fish itself was killed by the violence of the shock. The perforated beam, with the driven-in sword, are both preserved in the British Museum, and give a good idea of the prodigious power of the leviathans of the ocean.



SAW OF THE SAW-FISH.

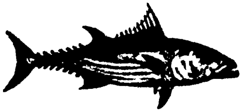


SWORD-FISH.

The **flying-fishes** are provided with pectoral fins of so great a length as to be able to carry them, like wings, a great distance through the air. They cannot raise themselves when in the atmosphere, and the elevation they take depends entirely on the power of the first spring or leap which they make on leaving their native element.

Their flight, as it is called, carries them fifteen or eighteen feet high over the water, and the lines which they traverse when they enjoy full liberty of motion are very low curves, and always in the direction of their previous progress in the water. Their silvery wings and blue bodies glittering beneath the rays of a tropical sun afford a most beautiful spectacle when, as is frequently the case, they rise into the air by thousands at once, and in all possible directions. The advantage afforded them by their wing-like fins in escaping from the pursuit of the bonitos and albicores often, however, leads to their destruction in another element, where gulls and frigate-birds frequently seize them with lightning-like rapidity ere they fall back again into the ocean. It is amusing to observe a bonito swimming beneath the feeble aëronaut, keeping him steadily in view, and preparing to seize him at the moment of his descent. But the flying-fish often eludes the bite of his enemy by instantaneously renewing his leap, and very often escapes by extreme agility. Flying-fish abound in tropical seas.

FLYING-FISH.


BONITO.

aër'-o-naut : a traveller through the air.
al'-bi-core : a sea fish of the tunny kind.
bo-ni'-to : a large fish found in warm seas.
den'-i-zen : an inhabitant.
East Indiaman : a name given to large ships which traded to India.
flex-i-bil'-i-ty : the quality of being easily bent.
pec'-tor-al : relating to the breast.
per'-for-at-ed : pierced by holes.
ser'-ra-ted : notched or cut like the teeth of a saw.
shears : a pair of cutters or large scissors.

34. ISLANDS OF THE PACIFIC.

The Pacific contains a vast number of islands, most of which are of very small size, and are all included under the term Polynesia. The chief groups are (1) **New Zealand,** consisting of two large islands and some smaller ones, all forming part of the British Empire. (2) A vast number of small coral islands lying in groups, the chief of which are the **Sandwich Islands,** the **Society Islands,** the **Caroline Islands,** the **Friendly Islands, Cook's Islands,** the **Marquesas Islands,** and many others. (3) A group of large islands lying between Australia and the south-east coast of Asia. The principal islands are **Borneo, New Guinea,** the **Philippine Islands, Japan Islands, Celebes, Moluccas,** the **Fiji Islands,** and many others.

The Friendly Islands.—'The view from the anchorage is of a flat coral beach, covered at high tide, and a strip of sand below a grass bank, from which spring the white stems and waving plumes of a cocoa-palm grove extending away to right and left, and mingling with trees and bush as it recedes from the village. The native huts lie scattered among the palm-trees, where white-kilted natives saunter about or sit in groups on the grass above the shore; others wade on the half-flooded beach, catching fish and picking up shells, or paddle about on the water in narrow outrigger canoes, which crowd round the ship laden with bananas, cocoa-nuts, yams, corals, pigs, poultry, &c.

The Fiji Islands.—'A ridge of high green hills; bold spurs—gorged deeply between—falling sharply into the sea; at the foot of a precipitous hill, between two projecting spurs, forming a shallow dent in the coast-line, is built a little European and native town, the former consisting mainly of a long straggling street facing the sea. A coral barrier reef, entered by a natural passage, bars the harbour. At the foot of the beautiful hillside stands Levuka, the seat of Fijian commerce. This group comprises two large islands with a great number of small ones. The largest is about eighty-five miles long by forty miles broad. Cotton grows well and is the chief export. The Fiji Islands now form part of the British Empire.

The Spice Islands.—'Amboyna is a beautiful island nearly divided in two by a broad sea inlet running between high hills, covered with forest or yellow grass, and along the shores are Malay villages half hidden in cocoa-groves. The population is a very queer one, and appears, as to race, most hopelessly intermingled. The upper class of the Malay women dress entirely in black and the poorer classes in bright colours. The canoes are a great sight; both here and at our first anchorage they came alongside full of fruit and eggs, and literally crowded with lories and cockatoos; while occasionally a cassowary with legs tied lies prostrate at the bottom of the canoe.

'The Malay fishermen fish by torchlight with spears and nets, and it is a pretty sight at night to see hundred of canoes, each with two or three torches, putting ou from the huts and villages along the length of the bay looking, when they get all together, like some large tow in the distance. Then in the early morning they al come paddling back, keeping close together, abreast in row, and as they pass the ship they strike up in chorus a boatman's song, keeping time to the double knock o their paddles against the sides of the canoes.

Manilla in the Philippine Islands.—'Manilla is built on an enormous land-locked bay, whose waters are so shallow that large ships have to lie two miles from the shore. Looking towards the town one sees domes, spires, red roofs, and ramparts rising from low ground which continues in rear and away on both sides till broken against the sky by a distant hill-range. The chief industry of the town is cigar-making.

Hawaii, Sandwich Islands.—'Hawaii is a very different-looking island from Oahu; gentle slopes of a vivid green surrounding and trending gradually up to the famous volcano of Mauna Loa, nearly 14,000 feet high; bold precipitous cliffs springing abruptly from the sea; numberless cascades falling over them, and in the line of cliffs frequent deep clefts, called gulches, with glistening waterfalls at their heads, and lawns, huts, and houses near the surf-beaten shore. This island contains Kilauea, one of the most wonderful volcanoes in the world. A great deal of sugar is grown, and there are vast herds of wild and semi-wild cattle.

Tahiti; Society Islands.—'The peculiarity of Tahiti's mountain scenery, as seen from the anchorage, is the small, sharp, angular ridges which everywhere tumble down the slopes, and the knife-edged summit of a magnificent green precipice, which, abruptly splitting the highest ridge in our view, drops sheer down into a deep ravine whose mouth opens seawards. The walls of this gorge, the clefts of the highest ridges, and a deep hollow on the right of the village are clothed with a dark green tree-vegetation; but the general vegetation looks scrub like and yellowish, scarred here and there a bright red where the soil is exposed.

A BOATMAN OF TAHITI.

The woods contain the most entrancing scenery and vegetation of unrivalled luxuriance. Here grow to perfection the bread-fruit, banana, and cocoa, and mingled among these are oranges, mangoes, citrons, limes, coffee, banyan, and a number of others, all in flower or fruit or both; a garden of Eden truly, and where one can eat almost of every tree.'—*Adapted from 'Log Letters from the "Challenger,"' Lord George Campbell.*

ba-na'-nas: the fruit of a large herbaceous plant.
cas'-so-wa-ry: a bird something like an ostrich; found in the East Indies.
cock-a-toos': a kind of parrot with a crest.
lor'-ies: a small bird very like a parrot.
Po-ly-ne'-si-a: many islands.
yams: a large root like a potato, growing in tropical countries.

35. HAWAIIAN SPORTS.

Before setting out for the Falls ourselves, we went to see the national sport of surf-swimming, for their skill in which the Hawaiians are so justly famed.

The natives have many other games of which they are very fond, and which they play with great skill, including spear-throwing, transfixing an object with a dart, *kona*, an elaborate kind of draughts, and *talu*, which consists in hiding a small stone under one of five pieces of cloth, placed in front of the players. One hides the stone, and the others have to guess where it is; and it generally happens that, however dexterously the hider may put his arm beneath the cloth, and dodge about from one piece to another, a clever player will be able to tell, by the movement of the muscles of the upper part of his arm, when his fingers relax their hold of the stone. Another game, called *parua*, is very like the Canadian sport of 'tobogging,' only that it is carried on on the grass instead of on the snow. The performers stand bolt upright on a narrow plank, turned up in front, and steered with a sort of long paddle. They go to the top of a hill or mountain, and rush down the steep, grassy, sunburnt slopes at a tremendous pace, keeping their balance in a wonderful manner.

With bows and arrows they are as clever as all savages and wonderfully good shots, attempting many wonderful feats. They are swift as deer, when they choose, though somewhat lazy and indolent. All the kings and chiefs have been special adepts in the invigorating pastime of surf-swimming, and the present king's sisters are considered first-rate hands at it. The performers begin by swimming out into the bay, and diving under the huge Pacific rollers, pushing their surf-boards —flat pieces of wood, about four feet long by two wide, pointed at each end—edgewise before them. For the return journey they select a large wave; and then, either sitting, kneeling, or standing on their boards, rush in shorewards with the speed of a racehorse, on the curling crest of the monster, enveloped in foam and spray, and holding on, as it were, by the milk-white manes of their furious coursers. It looked a most enjoyable amusement, and I should think that, to a powerful swimmer, with plenty of pluck, the feat is not difficult of accomplishment.

The natives here are almost amphibious. They played all sorts of tricks in the water, some of the performers being quite tiny boys. Four strong rowers took a whale-boat out into the worst surf, and then, steering her by means of a large oar, brought her safely back to the shore on the top of a huge wave.

After taking a few photographs it was time to return; and we next went to a pretty garden, which we had seen on the night of our arrival, and, tying up our horses outside, walked across it to the banks of the river. Here we found a large party assembled, watching half the population of Hilo disporting themselves in, upon, and beneath the water. They climbed the almost perpendicular rocks on the opposite side of the stream, took headers, and footers, and siders from any height under five-and-twenty feet, dived, swam in every conceivable attitude, and without any apparent exertion, deep under the water, or upon its surface.

But all this was only a preparation for the special sight we had come to see. Two natives were to jump from a precipice, 100 feet high, into the river below, clearing on their way a rock which projected some twenty feet from the face of the cliff, at about the same distance from the summit. The two men, tall, strong, and sinewy, suddenly appeared against the sky-line, far above our heads, their long hair bound back by a wreath of leaves and flowers, while another garland encircled their waists. Having measured their distance with an eagle's glance, they disappeared from our sight, in order to take a run and acquire the necessary impetus. Every breath was held for a moment, till one of the men reappeared, took a bound from the edge of the rock, turned over in mid-air, and disappeared feet foremost into the pool beneath, to emerge almost immediately, and to climb the sunny bank as quietly as if he had done nothing very wonderful. His companion followed, and then the two clambered up to the twenty-feet projection, to clear which they had had to take such a run the first time, and once more plunged into the pool below. The

HAWAIIAN SPORTS.

feat was of course an easier one than the first; but still a leap of eighty feet is no light matter. A third native, who joined them in this exploit, gave one quite a turn as he twisted in his downward jump; but he also alighted in the water feet foremost, and bobbed up again directly, like a cork. He was quite a young man, and we afterwards heard that he had broken several ribs not more than a year ago, and had been laid up for six months in the hospital.—*From Lady Brassey's 'Voyage in the "Sunbeam."'*

dex'-ter-ous-ly: cleverly; not clumsily.
im'-pe-tus: the force with which a body is propelled forwards.
in-vig'-or-at-ing: bracing up; strengthening.

36. THE CRATER OF KILAUEA.

First of all we descended the precipice, 300 feet in depth, forming the wall of the old crater, but now thickly covered with vegetation. It is so steep that here and there flights of zig-zag wooden steps have been inserted in the face of the cliff, in order to render the descent practicable. At the bottom we stepped straight on to the surface of cold boiled lava, which we had seen from above last night. It was the most extraordinary walk imaginable over that vast plain of lava, twisted and distorted into every conceivable shape and form, according to the temperature it had originally attained, and the rapidity with which it had cooled, its surface, like half-molten glass, cracking and breaking beneath our feet.

Sometimes we came to a patch that looked like the contents of a pot, suddenly petrified in the act of boiling;

THE CRATER OF KILAUEA.

sometimes the black lava had assumed the form of waves, or more frequently of huge masses of rope, twisted and coiled together; sometimes it was piled up like a collection of organ-pipes, or had gathered into mounds and cones of various dimensions. As we proceeded the lava became hotter and hotter, and from every crack arose gaseous fumes, affecting our noses and throats in a painful manner; till at last, when we had to pass to leeward of the molten stream flowing from the lake, the vapours almost choked us, and it was with difficulty we continued to advance.

At last we reached the foot of the present crater, and commenced the ascent of the outer wall. Many times the thin crust gave way beneath our guide, and he had to retire quickly from the hot, blinding, choking fumes that immediately burst forth. But we succeeded in reaching the top; and then what a sight presented itself to our astonished eyes! I could neither speak nor move at first, but could only stand and gaze at the horrible grandeur of the scene.

We were standing on the extreme edge of a precipice, overhanging a lake of molten fire, a hundred feet below us, and nearly a mile across. Dashing against the cliffs on the opposite side, with a noise like the roar of a stormy ocean, waves of blood-red, fiery, liquid lava hurled their billows upon an iron-bound headland, and then rushed up the face of the cliffs to toss their gory spray high in the air. The restless, heaving lake boiled and bubbled, never remaining the same for two minutes together. Its usual colour seemed to be a dull dark red, covered with a thin grey scum, which every moment and in every part swelled and cracked, and emitted fountains, cascades, and whirlpools of yellow and red fire, while sometimes one big golden river, sometimes four or five flowed across it. There was an island on one side of the lake, which the fiery waves seemed to attack unceasingly with relentless fury, as if bent on hurling it from its base. On the other side was a large cavern, into which the burning mass rushed with a loud roar, breaking down in its impetuous headlong career the gigantic stalactites that overhung the mouth of the cave, and flinging up the liquid material for the formation of fresh ones.

It was all terribly grand, magnificently sublime; but no words could adequately describe such a scene. The precipice on which we were standing overhung the crater so much that it was impossible to see what was going on immediately beneath; but from the columns of smoke and vapour that arose, the flames and sparks that constantly drove us back from the edge, it was easy to imagine that there must have been two or three grand fiery fountains below. As the sun set, and darkness enveloped the scene, it became more awful than ever. We retired a little way from the brink, to breathe some fresh air, and to try and eat the food we had brought with us; but this was an impossibility. Every instant a fresh explosion or glare made us jump up to survey the stupendous scene. The violent struggles of the lava to escape from its fiery bed, and the loud and awful noises by which they were at times accompanied, suggested the idea that some imprisoned monsters were trying to release themselves from their bondage, with shrieks and groans, and cries of agony and despair, at the futility of their efforts.

Sometimes there were at least seven spots on the borders of the lake where the molten lava dashed up furiously against the rocks—seven fire-fountains playing simultaneously. With the increasing darkness the colours emitted by the glowing mass became more and more wonderful, varying from the deepest jet black to the palest grey, from darkest maroon, through cherry and scarlet, to the most delicate pink, violet, and blue; from the richest brown, through orange and yellow, to the lightest straw colour. And there was yet another shade, only describable by the term 'molten-lava colour.' Even the smokes and vapours were rendered beautiful by their borrowed lights and tints, and the black peaks, pinnacles, and crags, which surrounded the amphitheatre, formed a splendid and appropriate background. Sometimes great pieces broke off and tumbled with a crash into the burning lake, only to be re-melted and thrown up anew.

From Lady Brassey's 'Voyage in the "Sunbeam."'

am'-phi-the-atre: a circular building without a roof, for sports and games.
cra'-ter: the mouth of a volcano.
crev'-ice: a crack or opening.
im-pet'-u-ous: that cannot be stopped.
e-mit'-ted: threw out.
pet'-ri-fi-ed: turned into stone.
mar-oon': dark red.

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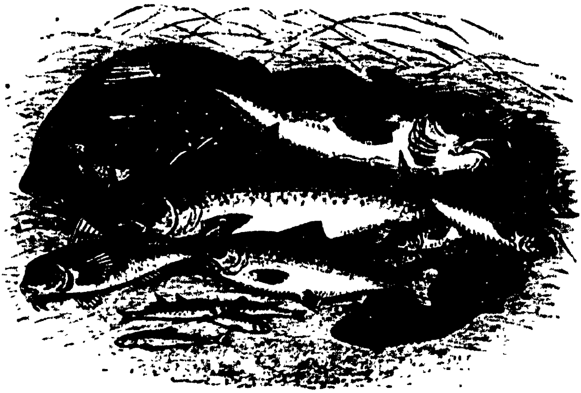
37. THE INHABITANTS OF THE SEA: FOOD FISHES.

Numberless are the various kinds of fishes which the ocean supplies to man, and almost every species affords an equally agreeable and health-giving food. But of all the finny tribe none can compare for utility with the **herring**, which, though small in size, is of the greatest importance. In shoals a mile long, and often so densely crowded with fish that a spear cast into them would stand upright in the living stream, the common herring appears annually on the coasts of North-Western Europe, pouring out the horn of abundance into all the lochs, harbours, fjords, and bays from Norway to Ireland.



GROUP OF FOOD FISHES.

Numberless sea-birds keep thinning their ranks through the whole summer; armies of rorquals, dolphins, seals, cods, and sharks devour them by millions; and yet so countless are their numbers that thousands of people live upon their spoils.

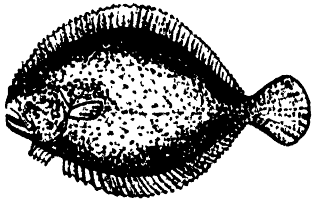
As soon as the season of their approach draws near, fleets of herring-boats leave the northern ports, provided with drift-nets about 1,200 feet long. The yarn is so thick that the wetted net sinks through its own weight, and need not be held down by stones attached to the lower edge, for it has been found that the herring is more easily caught in a slack net. The upper edge is suspended from the drift-rope by various shorter and smaller ropes, called buoy-ropes, to which empty barrels are fastened, and the whole of the floating apparatus is attached by long ropes to the fishing-boat. Fishing takes place only at night, for it is found that the fish strike the nets in much greater numbers when it is dark than while it is light. They come to the surface to feed at night because at a distance below there is not sufficient light to enable them to see their food.

The meshes of the net are exactly calculated for the size of the herring, wide enough to receive the head as far as behind the gill-cover, but not so narrow as to allow the pectoral fins to pass. Thus the poor fish, when once entangled, is unable to pass backwards or forwards, and remains sticking in the net until the fisherman hauls it on board.

The oldest mention of the herring fishery is found in the chronicles of the monastery of Evesham, of the year 709; and as far back as the days of William the Conqueror, Yarmouth was renowned for its herring fishery.

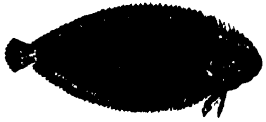
Although the common herring of our northern seas is beyond all doubt the most important of the tribe, yet there is no sea or coast where other species of the same family are not a source of food for man.

Thus the enormous shoals of **pilchards** appearing along our south-western coasts are not less valuable to the fishermen of Cornwall and Devon than the common herring is to those of the North Sea. When near the coast, the assemblage of pilchards assumes the arrangement of a mighty army with its wings stretching parallel to the land, and the whole is composed of numberless smaller bodies, which are perpetually joining together, shifting their position, and separating again.



TURBOT.

The cod family, to which, among others, the haddock, the whiting, the ling, and other valuable fishes belong, ranks next to that of the herring in importance to man. The cod is found from Iceland to very nearly as far south as Gibraltar, but is found most abundantly near the eastern coast of North America.



SOLE.

In fishing for cod sometimes a hand-line is used, but more often a line from one to two thousand fathoms long is let down, having fastened to it innumerable depending lines of three feet to a fathom in length, with over a thousand hooks attached. This is anchored and buoyed in a straight line by two men in a small boat. Six of these long lines are usually set by the crew of a fishing schooner. Large fleets of fishing-boats are constantly employed in cod-fishing off the banks of Newfoundland. Here they are exposed to violent storms, to intense cold, and also to dense fogs, during which many a fishing-vessel is run over by the great Atlantic liners, which pass on having scarcely felt a shock, while for the poor drowned fishermen many a home will be desolate in the long days to come.

Of the other food fishes the **sturgeon** is the largest. It is found chiefly in the large rivers and in the estuaries of Russia, where it sometimes exceeds a thousand pounds in weight. It is also caught off the coasts of the British Isles. Among other fish we may mention the **mackerel** and the many kinds of flat-fish, of which the best known are the **turbot, sole, plaice,** and **skate.** But we have yet to speak of the **salmon,** the king of the fishes, which is the most highly prized of all, both for the sport he gives the fisherman as well as for the delicacy of the flavour of his firm pink flesh.

Ev′-es-ham: a town on the R. Severn.
mon′-as-te-ry: a building where a colony of monks live secluded from the world.
per-pet′-u-al-ly: constantly.
Yar′-mouth; a fishing-town in Norfolk.

CRUSTACEANS AND OYSTERS.

38. THE INDIAN OCEAN.

Position and Size.—The Indian Ocean is the great body of water which lies to the south of Asia. It has the coast of Africa as its western limit; the large islands of Polynesia lie between it and the waters of the Pacific; while on the south the Antarctic Circle forms an artificial boundary between it and the Antarctic Ocean. Hence we see it is open to the waters of all the great oceans except those of the Arctic Ocean. In one respect it affords a striking contrast to the Atlantic and Pacific, for whereas these oceans extend to the same distance on each side of the Equator, the Indian Ocean lies to the south of the Tropic of Cancer. This fact has an important bearing in determining both its currents and winds. If we measure its breadth along the Equator we find that it is about 4,000 miles, and it widens out farther to the south. Its length is about 6,000 miles, and its area comprises about 25 millions of square miles. Its average depth is about 2,500 fathoms, but soundings of 3,000 fathoms have been taken in the eastern parts. The northern part of the Indian Ocean is very warm, as in summer its waters are heated by the land as well as by the sun, and, further, it is not open to the cold waters of the Arctic Ocean. It is much colder in the south, owing to the constant creep of cold water from the Southern Ocean.

Winds.—In the Indian Ocean the trade wind blows constantly from 10° S. lat. to 30° S. lat.; but to the northward of this the winds change every six months and blow directly opposite to their former course. These regular winds are called **monsoons**, from a Malay word meaning a season. When they shift their direction violent storms and variable winds succeed, and these last for about a month, during which time it is dangerous for ships to continue at sea.

Over all the Indian Ocean to the northward of the third degree of south latitude, the north-east trade wind blows from October to April, and the south-west monsoon blows from April to October. Now why is it that for six months in the year the north-east trade winds blow from exactly the opposite direction? When the sun approaches the Tropic of Cancer, it is over the great masses of land which form the south of Asia. The land and air become intensely hot, and the hot air rises. Cold breezes from the Indian Ocean blow northwards to fill the place of the heated air, and the direction is turned towards the east because the air from the ocean is leaving swiftly rotating parts of the earth and moving towards slower ones. Hence the air is moving faster than the land beneath it, and, as the earth is turning to the east, the wind also blows in the same direction—that is to say, it seems to blow from the south-west. In this way the south-west monsoon is caused.

From October to April, when the sun is south of the Equator, the ocean is much hotter than the land in the south of Asia; the air over the seas becomes heated and rises, and cool winds blow from the land to fill its place. This is the cause of the north-east trade wind, or the north-east monsoon, as it is often called. There are many other season winds in the Indian Ocean, but those just described are by far the most important. It is the south-west monsoon which brings heavy rains to India.

Cyclones and tornadoes also often blow in the Indian Ocean.

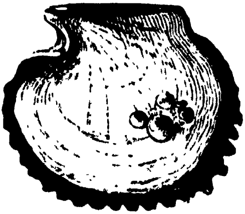
Currents.—We have seen in a former lesson that the winds help to cause and to modify the direction of ocean currents. This is seen very plainly in the Indian Ocean, where the **Equatorial Current** loses much of its force because the trade winds do not blow with the same regularity as they do in the Atlantic and Pacific. The Equatorial Current flows across the northern part of the ocean to the west. When it approaches the shores of Madagascar it splits into two branches. One travels round the north of the island, and bending to the south passes through the Mozambique Channel. The other moves southward along the eastern side of the island. These two branches then unite, and form a current flowing southwards. When this reaches the neighbourhood of Cape Colony it again divides. One branch flows into the Atlantic, and the other, bending east, moves slowly across the ocean towards Australia, and, turning northwards, is again swept into the Equatorial Current. This southern current is of the greatest use to sailors, for it moves through a part of the ocean where westerly winds prevail, and so the ship is gently wafted forward by both wind and stream. No wonder that outward-bound ships to Australia always take this route.

Islands.—The chief island of the Indian Ocean is **Madagascar.** It is about a thousand miles in length, and has a fine climate and plenty of fertile soil, though in parts it is very mountainous. A part of it is now under the protectorate of France. **Ceylon** is a large island lying to the south of India. It is very fertile, and produces coffee, cinnamon, and other spices. Two groups of islands, the **Maldives** and **Laccadives**, lie out in the ocean, and consist of numbers of atolls which the coral-animals have built upon low-lying rocks or upon the craters of extinct volcanoes.

cra'-ter: the mouth of a volcano.	**cin'-na-mon**: the spicy bark of a laurel which grows in Ceylon.
mo'-di-fy: change.	

89. THE PEARL FISHERY OF CEYLON.

A SHELL nearly related to the oyster produces the costly pearls of the East that have ever been as highly esteemed as the diamond itself. The most renowned pearl fisheries are carried on at Bahrein, in the Persian Gulf, and in the Bay of Condatchy, in the island of Ceylon, on banks situated a few miles from the coast. Before the beginning of the fishery, the Government causes the banks to be explored, and then lets them to the highest bidder, very wisely allowing only a part of them to be fished every year. The fishing begins in February, and ceases by the beginning of April. The boats employed for this purpose assemble in the bay, set off at night at the firing of a signal-gun, and reach the banks after sunrise, where fishing goes on till noon, when the sea-breeze which arises about that time warns them to return to the bay. As soon as they appear within sight, another gun is fired, to inform the anxious owners of their return. Each boat carries twenty men and a chief; ten of them row and hoist up the divers, who are let down by fives—and thus alternately diving and resting keep their strength to the end of their day's work. The diver, when he is about to plunge, compresses his nostrils tightly with a small piece of horn, which keeps the water out, and stuffs his ears with bees'-wax for the same purpose. He then seizes with the toes of his right foot a rope to which a stone is attached, to accelerate the descent, while the other foot grasps a bag of network. With his right hand he lays hold of another rope, and in this manner rapidly reaches the bottom. He then hangs the net round his neck, and with much dexterity and all possible despatch collects as many oysters as he can while he is able to remain under water, which is usually about two minutes. He then resumes his former position, makes a signal to those above by pulling the rope in his right hand, and is immediately by this means hauled up into the boat, leaving the stone to be pulled up afterwards by the rope attached to it. Accustomed from infancy to their work, these divers do not fear descending repeatedly to depths of fifty or sixty feet. They plunge more than fifty times in a morning, and collect each time about a hundred shells. Sometimes, however, the exertion is so great that, upon being brought into the boat, they discharge blood from their mouth, ears, and nostrils.


CEYLON PEARL-OYSTER.

While the fishing goes on, a number of conjurers and priests are assembled on the coast, busily employed in protecting the divers by their incantations against the voracity of the sharks. These are the great terror of the divers, but they have such confidence in the skill or power of their conjurers that they neglect every other means of defence. The divers are paid in money, or receive a part of the oyster-shells in payment. Often, indeed, they try to add to their gains by swallowing here or there a pearl, but the sly merchant knows how to find the stolen property. The oysters, when safely landed, are piled up on mats, in places fenced round for the purpose. As soon as the animals are dead, the pearls can easily be sought for and extracted from the gaping shells. After the harvest has been gathered, the largest, thickest, and finest shells, which furnish mother-of-pearl, are sorted, and the remaining heap is left to pollute the air. Some poor Indians, however, often remain for weeks on the spot, stirring the putrid mass in the hopes of gleaning some forgotten pearls from the heap of rottenness. The pearls are drilled and stringed in Ceylon, a work which is performed with admirable dexterity and quickness. For cleaning, rounding, and polishing them, a powder of ground pearls is made use of.

The Pacific also furnishes these costly ornaments to wealth and beauty, but the pearls of California and Tahiti are less prized than those of the Indian Ocean.—*From Hartwig's 'The Sea and its Living Wonders.'*

ac-cel'-er-ate: hasten; to quicken.
al-ter'-nate-ly: one after the other.
con'-jur-er: one who practises magic; who pretends to have a power that other men have not.
in-can-ta'-tions: the magical words or charms sung by conjurers.
Ta-hi'-ti: the largest of the Society Islands.

40. CANOEING IN THE MOLUCCAS.

AND now there befell us a great adventure, of whose pleasantness or otherwise I leave you to judge. Since the forenoon a fresh breeze had sprung up, the sky was clouded, and the sea flecked with white horses, so much so that our Indian canoe-men would not go over; but we said, 'Oh, nonsense!' The old Rajah and his son said 'No, no!' and went through a pantomime indicating much sea, much wind, much roll, and final turn over. After a time we went to the canoe and found the men lashing extra bamboo spars to the outriggers, which looked like going after all. Our rifles, cartridge-bags, &c. were put in; and though the Rajah's son positively refused to shake hands and say good-bye to us (which he thought would look like conniving at our madness), even offering to take us over in a large canoe-boat, though everybody looked anxious and evidently thought 'danger,' we only laughed and said 'We swim,' M. particularly implying his readiness to swim to the other side if anything happened. And so, like asses, we shoved off, our Indians, like bigger asses, agreeing thereto.

We set the small sail, and for several hundred yards flew over the surface of the sea in an exceedingly merry way; but of course—as we very soon saw was inevitable—when half a mile from our starting-point, flop, in came one vicious wave, and flop came another, nearly filling the canoe, and flop came a third, and down we sank—sank bodily, canoe and all, still retaining our respective positions till the sea came up to our chests; then, happily, the conditions of buoyancy seemed satisfied, and there we were, a very fine state of affairs! Nothing of the canoe was visible excepting its slight mast and small sail flapping wildly above the waters; we almost immersed, with frequent waves washing up to nearly our shoulders, making us heave deep, cold *soughs* every time, With the second wave, before we had either time to lose or regain our presence of mind, away floated the flying fox, and away floated a large tin botanical affair, which did once contain our lunch, but now small birds. The Indian in the bows held on manfully to the rifles, though of course under water. C. handed me a silver pewter—which he had borrowed without leave—and his coat to take care of, the first of which I promptly let drop to the bottom of the canoe, but the coat I held, and when we were rescued afterwards, C. was awfully aggrieved because I had not kept it *dry*. 'Why,' said he naively, 'that was the reason I gave it to you,' which was, I think, the best joke I ever heard.

And all this time we roared and screamed like Britons for assistance, while we went deeply floating on with perfect safety, that is to say, with perfect-safety feeling, after we were sure that the canoe was not going to sink lower; the only thing to do was carefully to maintain the perpendicular, so as to prevent the canoe from turning over on its side, or altogether, for then good-bye to our guns, pewter pots, and possibly ourselves. Our chief concern was C., who, at the first wave, stood up, supporting himself by my shoulders, and we had the greatest difficulty to prevent him trying to swim on shore and send us assistance. He and M. had quite a hot argument about some former example of C.'s powers in the swimming way, in which C. said he *had* done so and so then, and could easily do this now; while M. maintained that he had *not* done so and so then, and could not do this now. 'But go on, go on, my dear fellow, and I'll bet you, if you do try it, you will not reach the shore!'

We drifted along fast, I vainly trying to paddle the canoe towards the land (but I found that a paddle did not influence to any appreciable extent a canoe immersed some distance beneath the water, and in it five men—odd, was not it?), parallel to which, and about three-quarters of a mile off, we were drifting. So, for about twenty-five minutes, laughing, joking, scolding C., trying to keep him quiet, and not very apprehensive about matters in general, we sailed along beneath water, and then saw two canoes—one manned by women—paddling out with all speed from some huts on shore, while behind us, at the village we had left, we saw a large canoe-boat being launched by a crowd of men, and coming up fast under a score of energetically worked paddles. The first two took us to land, and then the large one took us back to the village, while our Indians baled out their canoe and afterwards sailed safely over in a decidedly nasty chop of sea, and even this large canoe-boat was taking in more water han they liked. The men laughed at us tremendously, n which we heartily joined, the swimming part of our rogramme being all rehearsed by them for our benefit.

They are a most pleasant people, and got—the Rajah's son in command—a larger canoe-boat ready, and then with him, some twenty paddlers and a large sail, we paddled and sailed across to the ship in no time. So happily ended that adventure; but if it had been later in the dusk, or if we had got further from land before we filled, we might have drifted for a very disagreeably long time, and as there are big sharks in the bay, things might not have ended quite so nicely as they did.—*Lord George Campbell, Log Letters from the 'Challenger.'*

(By permission of Messrs. Macmillan.)

con-niv'-ing: agreeing to; winking at a fault.	
in-ev'-it-able: that cannot possibly be avoided.	
out'-rig-ger: a projecting spar from the side of a boat to increase its stability: also applied to a projecting rowlock.	
Ra'-jah: the title given to chiefs among the Malays.	

41. COOK'S VOYAGES.

To form a correct estimate of Cook's discoveries, it is necessary that, before following the track of that great seaman, we should glance over the vast regions of the Pacific previously unknown to man. Many navigators indeed, since Magellan, had traversed that immense ocean, but the greater part of its expanse still lay buried in obscurity.

No one had yet tried to sail through the boundless space which to the south of the 25th degree of latitude extended between New Zealand and America. Of Australia only the western coast was known; the existence of Torres' Strait had long since been forgotten, and New Guinea and New Holland were supposed to form one connected land. To the south no one knew whether Australia and Tasmania were joined together, or severed by a channel; and the eastern coast of the fifth part of the world still awaited a discoverer. The boundaries of New Zealand were buried in the same obscurity, and in the unexplored bosom of the South Sea there yet was room enough for lands surpassing the whole of Europe in extent. Many of the South Sea islands moreover, though discovered before Cook's voyages, had vanished again from the memory of the world. Thus two hundred and fifty years after Magellan the Pacific still offered an enormous field for discovery, and when Cook set sail on July 30, 1768, on his first voyage of circumnavigation, nearly one half of the globe lay open to his researches.

The first service he rendered on this voyage was the discovery that the route to the Pacific through the Strait of Le Maire and round Cape Horn was preferable to that which until then had been followed, through the Straits of Magellan.

After having observed at Otaheite the transit of Venus across the sun, which was one of the chief objects of the expedition, he soon after landed on the shores of the Society Islands, which was the name he bestowed upon them on account of their close vicinity to each other. Thence he sailed to New Zealand, which he was the first to find consisted of two large islands, separated by the strait which bears his name. With unwearied industry he spent no less than six months on the accurate survey of the New Zealand group, and then sailed to New Holland, the eastern coast of which he first discovered, and closely examined in its full length of 2,000 miles. He also found that the continent of Australia was separated from New Guinea by a channel which he called 'Endeavour Strait,' but to which the justice of posterity has restored or awarded the name of Torres, its first explorer. This whole sea is so full of dangerous reefs and shoals that for months the sounding line was scarce ever laid aside, and any less experienced and prudent navigator must inevitably have been wrecked during these constant cruises in such perilous waters. Even Cook was more than once in danger of losing his ship, and on one occasion he had a marvellous escape.

It was on June 10, 1770. The vessel sailed, under a fresh breeze and by clear moonlight, through a sea the depth of which the plummet constantly indicated at twenty to twenty-one fathoms, so that not the least danger was apprehended. But suddenly the depth diminished to four fathoms, and before the lead could be heaved again the vessel struck and remained immoveable, except as far as she was heaved up and down and dashed against the rocks by the surge. It was found that the ship had been lifted over the ledge of a rock and lay in a hollow, inside the reef, where the water in some places was three or four fathoms deep and in others hardly as many feet. The sheathing boards were knocked off and floating round the ship in great numbers, and at last the false keel also was destroyed, while the constant grating of the vessel against the rock seemed to announce its breaking up. It was now necessary to lighten the vessel as much as possible, and soon more than 50 tons' weight was thrown overboard.

On the following morning land was seen at the distance of eight miles; but no islet lay between, on which, in case the vessel went to pieces, a speedy refuge might be found. To add to their distress, the vessel took in so much water that three pumps could hardly master it; and, finally, it was found that even the rising of the tide was unavailing to extricate them from their perilous position. All that could possibly be spared was now therefore cast into the sea, still more to lighten the vessel, and thus the next tide was patiently expected, when, after incredible exertion, the ship righted, and they got her over the ledge of the rock into deep water.

But the men were by this time so much exhausted by their uninterrupted labour that they could not stand to the pumps more than five or six minutes at a time, after which they threw themselves flat on the streaming deck, where they lay till others exhausted like themselves took their places, on which they started up again and renewed their exertions. In this desperate situation one of the midshipmen, named Monkhouse, bethought himself of a means by which a ship, having sprung a leak admitting more than four feet of water in an hour, had yet been able to perform the whole journey from Virginia to London. He took a lower studding-sail, and, having mixed a large quantity of oakum and wool together, stitched them down by handfuls as lightly as possible. The sail was then hauled under the ship's bottom by means of ropes which kept it extended. When it came under the leak; the wool and oakum, with part of the sail, were forced inwards by the pressure of the water, which thus prevented its own ingress in such an effectual manner that one pump, instead of three, was now sufficient to keep it under. In this way they got the ship into a convenient port on the coast of New Holland, where they repaired the injury. Here it was found that their preservation was not entirely owing to that ingenious expedient, for one of the holes in the ship's bottom was almost entirely plugged by a piece of rock which had broken off and stuck in it; and this hole was so large, that, had it not been filled up in this truly extraordinary manner, the vessel must undoubtedly have sunk.

With a vessel thus shattered, and a crew thus worn with fatigue, further discoveries were no more to be thought of, and Cook hastened to return by way of

Batavia and the Cape to England, where he arrived on June 11, 1771. Cook made two other voyages to the Pacific, and on the third he was killed by the savages in the Sandwich Islands.

Batavia: the chief town in the island of Java.
cir-cum-na-vi-ga'-tion: sailing round the world.
New Holland: the name first given to Australia.
oak'-um: old ropes pulled out into loose hemp, and used for caulking the seams of ships.
Otaheite: Tahiti, the largest of the Society Islands.
plum'-met: the lump of lead fastened to the end of a sounding-line.
shat'-ter-ed: damaged.
studding sail: a sail projected by spars outside the hull of a ship.

42. THE INHABITANTS OF THE SEA: BIRDS. (I.)

COUNTLESS are the birds of the wood and field, of the mountain and the plain; and yet it is doubtful whether they equal in number those of the fish-teeming seas. For every naked rock or surf-beaten cliff that rises over the immeasurable deserts of ocean, is the refuge of myriads of sea-birds; every coast, from the poles to the equator, is covered with their legions, and far from land their swarms hover over the solitudes of the deep. Many, unfit for swimming, seek their food along the shores; others rival the fishes in their own native element; and others, again, armed with indefatigable wings, pursue their prey upon the high seas. But, however different the mode of living of the numerous kinds of sea-birds may be, each of them is organised in the most perfect manner for the wants of its own peculiar sphere.

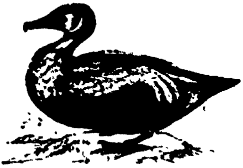
Take, for instance, the **strand-birds**, that live on the margin of the ocean, and feast upon the shell-fish and sea-worms that live upon the shore mostly between high and low water mark. How admirably the light weight of their small body suits the soft yielding soil on which they have to seek their food; how well their long legs are adapted for striding through the mud of the shallow waters; and their long bill and flexible neck are beautifully formed for seizing their fugitive prey, ere it can bury itself deep enough in the safe mud or sand.

If we examine the real sea-birds, such as are formed for swimming or diving, or for wide flights over the deserts of ocean, we shall find them no less wonderfully organised than the winged dwellers on the strand. Their short compressed toes easily cleave the waters, and by means of their membranes or webs form, as it were, broad oars. Their muscular short legs, placed more behind than in other birds, are beautifully adapted for rowing, although their movements on land are awkward and slow. All creatures living on the sea require a thick waterproof mantle against weather and storm; and consequently we find the plumage of sea-birds thicker, closer, and better furnished with down than that of the other feathered tribes. And finally, the gland, which all kinds have and from which they discharge an oily matter to keep their feathers moist, is largest among those that live upon the water, and helps to prevent the water from soaking through their plumage. Surely the sea-bird has no right to complain of imperfect clothing or a deficient outfit.

The numerous members of the duck family mostly live during the summer in higher latitudes, and wander in winter in countless swarms towards sunnier regions; as, for instance, the **snow goose** and the **barnacle.** Some remain throughout the year in Great Britain, some only during the winter; while others, which are more particularly birds of the Arctic zone, but very seldom make their appearance in our southern clime.

BARNACLE GOOSE.

The **eider duck,** which attains nearly double the size of the common duck, inhabits the higher latitudes of Europe, Asia, and America. One of its most remarkable breeding places is upon a small island near Iceland, where it lives during the breeding season under the protection of the law.


EIDER DUCK.

'As our boat approached the shore,' says Mackenzie ('Voyage through Iceland'), 'we came through a multitude of these beautiful birds, who hardly gave themselves the trouble to move out of the way. Between the landing-place and the house of the old governor the ground was covered with them, and it was necessary to walk cautiously not to tread upon their nests. The ganders went about with a cackle resembling the cooing of a pigeon, and were even more familiar than our common duck. Round about the house, on the garden wall, on the roofs, even in the inside of the huts and the chapel, they sat breeding in great numbers. Those which had not been long upon their nests generally left at our approach, but those which had more than one or two eggs remained undisturbed, allowed themselves to be handled, and sometimes even gently used their bills to remove our hand. The nests were lined with down, which the mother plucks from her own breast; and near at hand a sufficient quantity was piled up to cover the eggs when she goes to feed, which is generally at low water. The downs are twice removed, but sometimes the poor duck is obliged to provide for a fourth lining; and when she has no more to spare, the gander willingly deprives himself of part of his showy snow-white and rose-red garment. The eggs, which are considered a great delicacy, are also partially taken away. When boiled, they are tolerably good, but always very inferior to those of our domestic hen. When taken from the nest, the downs are mixed with feathers and straw; and to sort and prepare them for sale is part of the winter employment of the women. One nest furnishes about a quarter of a pound of cleaned downs. The softness, lightness, and elasticity of these feathers is universally known.'

Almost as soon as the young have left the eggs, the mother conducts them to the water's edge, takes them on her back, and swims a few yards with them, when she dives and leaves them on the surface to take care of themselves. As soon as they have thus acquired the art of swimming, the duck returns and becomes their leader. The bird is found on the Orkney and Shetland Islands, and breeds on May Island at the mouth of the Firth of Forth.

down: the soft feathers found on the breasts of sea-birds.	**in-de-fat'-ig-able**: never tiring.
com-press'-ed: squeezed together.	**or'-gan-is-ed**: put together or built.

43. THE ARCTIC OCEAN.

The Arctic Ocean is bounded by the northern coasts of Europe, Asia, and America, and by the Arctic Circle, that is to say it comprises all the waters lying within a circle 23½° from the North Pole, and includes an area of about three millions of square miles of water. It is connected with the Atlantic Ocean by a wide strait between Greenland and Norway, and with the Pacific Ocean by Behring's Strait. It is for a large part of the year completely choked with ice, but there is water-communication in summer connecting it with the Atlantic and the Pacific.

Currents.—It has been proved that there is a constant creep of the cold waters from the Arctic Ocean towards the south. Many a bold seaman has found that though his ship was cased in the ice as with an iron band, that still ice and ship together have moved southward for hundreds of miles. The strength of this current may be seen from the fact that in the summer of 1857 the ship 'Fox' which was enclosed by ice drifted southwards for a distance of nearly 1,200 geographical miles. This movement of the waters is felt most in Davis Straits, through which a constant current flows into the Atlantic and carries with it ice-fields, floes, and huge bergs. As it approaches the latitude of about Newfoundland it meets with the warm waters of the Gulf Stream moving northwards. The cold water being much denser than the warm water gradually sinks, and so becomes lost as a current at the surface, though it continues its southerly course nearer the ocean-bed.

Islands.—The principal islands of the Arctic Ocean lie in the archipelago which is situated to the north of America, and of which the largest is Greenland. There are also the Spitzbergen Group, Nova Zembla, and Iceland. The latter is not within the Arctic Circle, but its climate is so severe that it may well be described with the islands of the Polar Seas.

'Iceland might as well have been called Fireland, for all its 40,000 square miles have originally been upheaved from the depths of the waters by volcanic power.' In winter, when an almost perpetual night covers the wastes of this fire-born land, and the waves of a stormy ocean thunder against its shores, imagination can hardly picture a more desolate scene; but in summer the rugged nature of Iceland invests itself with many a charm. The interior is covered with deserts of volcanic stone, and ice-fields with lofty volcanoes rising high above them. In some parts of the island there are lava-streams of gigantic proportions which have cooled down into the most fantastic forms.

In other places boiling springs and boiling mud-cauldrons send forth clouds of steam and completely hide the view. The latter are filled with a thick slimy gray or black liquid, boiling or simmering with greater or less vehemence, and sending forth dense volumes of steam more or less mixed with sulphurous gases. But the most striking of the many wonderful sights to be seen in Iceland are the geysers or boiling-springs. These in hundreds of places gush forth from the foot of the mountains. Some are of a gentle and even flow, and can be used for bathing, washing, or boiling. But of all the springs and fountains of Iceland there is none to equal the Great Geyser.

In the course of countless ages this monarch of springs has formed, out of the silica it deposits, a mound which rises to about thirty feet above the general surface of the plain, and slopes on all sides to a distance of about a hundred feet. In its centre is a circular basin about fifty feet across, and in the middle of this basin, forming as it were a gigantic funnel, there is a pipe or tube about sixteen feet in diameter.

Generally the whole basin is filled up to the brim with sea-green water as pure as crystal, and with a temperature of from 180° to 190°, or only about 20° less than boiling-point. Suddenly a subterranean thunder is heard, the ground trembles under foot, the water in the basin begins to simmer, and large bubbles of steam rise from the tube and burst on reaching the surface, throwing up small jets of spray to the height of several feet. Now the water in the basin becomes violently agitated; the tube boils vehemently; and suddenly a magnificent column of water, clothed in a vapour of dazzling whiteness, shoots up into the air with great force and noise to the height of seventy or eighty feet, and spreading out at its highest point, showers water and steam in every direction. A second eruption and a third rapidly follow, and after a few minutes the fairy spectacle has passed away like a fantastic vision.

Iceland was discovered as far back as the year 861 A.D., when a Norwegian pirate while sailing from his native coast to the Faroe Islands was drifted by contrary winds far to the north and landed upon its shores. Returning to his native land he described the island he had found, and within the next ten years bodies of emigrants from Norway founded settlements there.

The capital of the island is Reykjavik, which contains about 1,400 inhabitants. The people live almost entirely upon the products of their fisheries, and by catching the many kinds of sea-fowl which abound.

boiling-point: the boiling-point of fresh water is 212° Fahr.

floes: flat-topped lumps of floating ice.

si′-li-ca: the most common form is flint; silica enters very largely into the composition of the solid parts of the earth.

sub-ter-ra′-ne-an: underground.

ve-he′-mence: force or violence.

44. THE ARCTIC OCEAN: ICE AND SNOW.

In winter the Arctic regions are held fast in the grip of the Ice King. Land and sea alike are covered with ice and snow. Belated whalers are frozen fast, and must wait icebound till the warmth of the following summer loosens the iron hold and frees them. Even in summer the voyager finds his passage barred by ice-floes, ice-fields, icebergs, and lumps of floating ice of all shapes and sizes, and it is only by the most careful navigation and by seizing the opportunity of forcing a way through every opening in the ice that he can make progress to the north.

The cold is so intense that the mercury freezes in the thermometer, and the spirit thermometer sometimes registers a temperature as much as 100° below the freezing-point of water.

The Aurora Borealis.—In the long Arctic day the sun describes a circle in the sky, but is so low upon the horizon that only a few rays fall upon a given space. In the long Arctic night the stars give forth a dim light, but the deep gloom is sometimes illuminated by all the glories of the Aurora. 'Night covers the snow-clad earth. The stars glimmer feebly through the haze which so frequently dims their brilliancy in the high latitudes, when suddenly a broad and clear bow of light spans the horizon. This bow sometimes remains for several hours, heaving or waving to and fro, before it sends forth streams of light ascending to the zenith. Sometimes these flashes proceed from the bow of light alone; at others they simultaneously shoot forth from many opposite parts of the horizon, and form a vast sea of fire whose brilliant waves are continually changing their position. Finally they all unite in a magnificent crown or cupola of light, with the appearance of which the phenomenon attains its highest degree of spendour. The brilliancy of the streams, which are commonly red at their base, green in the middle, and light yellow towards the zenith, increases, while at the same time they dart with greater vivacity through the skies. The colours are wonderfully trans-

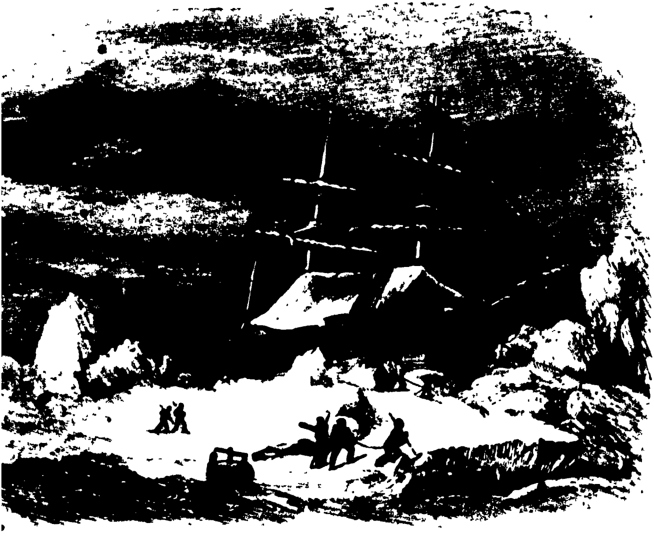
AN ICEBERG.

parent, the red approaching to a clear blood-red, the green to a pale emerald tint. The dark sea, black as jet, forms a striking contrast to the white snow plain or the distant ice mountain; all the outlines tremble as if they belonged to the unreal world of dreams.'

Ice-fields and Icebergs.—Arctic navigators have given various names to the different kinds of masses of ice which are found in the Polar seas. They are **icebergs** when they tower to a considerable height above the waters, and **ice-fields** when they are not very lofty, but spread over a wide area. An **ice-floe** is a piece that has been broken off from an ice-field. When a large number of floes are driven together by winds and currents so as to form a barrier impassable to ships, they form a **pack**. A pack in course of formation or when it is being scattered again is broken up into a number of floating masses called **drift-ice**, through which ships can with difficulty force a way.

In summer the ice-fields move slowly to the south, and at first the ice of which they are composed is of the average thickness of from ten to fifteen feet. Their surface is sometimes smooth, but more often is covered with numberless hummocks piled up in the wildest confusion. These moving fields of ice are sometimes driven forward by the wind and current with great swiftness, and occasionally masses of ice which measure miles across come into collision with terrific force. Woe to the hapless ship that may be between them! For though whalers are built of great strength the ice crushes their sides as it would the shell of an egg, or else lifting the ship from the water the ice heaves it up bodily upon the ice-field.

Some of the icebergs are of immense size. Dr. Hayes easured a berg which stood 315 feet out of the water, id was over three-quarters of a mile in length. As ly about one-seventh of the height of a berg appears ove the water, this would have gone aground at a depth about half-a-mile. As the bergs float into warmer ters they melt away, and are washed to pieces near the



VESSEL LIFTED OUT OF THE WATER BY ICE.

rface of the sea. In this way they sometimes become p-heavy, and with a terrific crash they topple over, reaking into a thousand pieces.

'The bergs,' says Dr. Hayes, describing them when athed in the light of the midnight sun, 'had wholly st their chilly aspect, and, glittering in the blaze of the brilliant heavens, seemed in the distance like masses of burnished metal or solid flame. Nearer at hand they were huge blocks of Parian marble, inlaid with mammoth gems of pearl and opal. One in particular exhibited the perfection of the grand. Its form was not unlike that of the Colosseum, and it lay so far away that half its height was buried beneath the line of blood-red waters. The sun, slowly rolling along the horizon, passed behind it, and it seemed as if the old Roman ruins had suddenly taken fire. In the shadow of the bergs the water was a rich green, and nothing could be more soft and tender than the gradations of colour made by the sea shoaling on the sloping tongue of a berg close beside it. The tint increased in intensity where the ice overhung the water, and a deep cavern near by exhibited the solid colour of the malachite mingled with the transparency of the emerald, while in strange contrast a broad streak of cobalt blue ran diagonally through its body. The bewitching character of the scene was heightened by a thousand little cascades which leaped into the sea from these floating masses, while the slow moving swell of the ocean resounded through their broken archways.'

burn'-ish-ed; polished.
Col-os-se'-um: the largest amphitheatre in the world, at Rome.
o'-pal: a precious stone of a milky hue, remarkable for changing its colours.
Parian marble: found in the island of Paros in the Ægean Sea.
ma'-la-chite: a green-coloured mineral; the green is due to the presence of copper.
mam'-moth: of huge size; the mammoth was a species of elephant of very large size, now extinct.
si-mul-ta'-ne-ous-ly: happening at the same time.
spirit thermometer: the ordinary thermometer contains mercury, but this freezes in very cold regions, and so spirits of wine are used.
trans-par'-ent: easily seen through.
zen'-ith: the point in the heavens directly overhead.

45. THE ARCTIC OCEAN: THE ESQUIMAUX.

All the islands of the Arctic Ocean exhibit a naked and dreary surface. Steep rocks rise from the coast, and the surface of the interior is buried under ice and snow for about ten months in the year. Bears and Arctic foxes are found as far north as men have penetrated. Seals and walruses live in the seas. Sea birds of many kinds abound in the short summer. But in winter desolation reigns supreme.

Of all the islands of the Arctic Ocean, Greenland is in many respects the most remarkable. It is probably larger than Australia, but of all this vast extent of territory only the narrow shores of the coast-line are inhabitable or even accessible to man. On penetrating into the deeper fjords, all the valleys are found blocked with glaciers, which seem to cover the interior. Huge masses break away from these glaciers and float away as icebergs.

The present Danish settlements of Greenland are confined to the more sheltered fjords of the west coast, and the best known is that of Upernavik. The bulk of the population consists of the original inhabitants the Esquimaux, and a few Europeans.

The Esquimaux.—The Esquimaux are found in all parts of the Arctic Ocean. They live in regions that are covered with ice and snow for the greater part of the year, and where vegetation is reduced to mosses, lichens, and grasses, and where the only trees are a few stunted willows. For six months of every year the sun is invisible, and they have to depend upon the light of the stars and the wondrous Aurora Borealis. They are never found very far away from the coast, for it is to the cetaceans and fishes of the seas that they owe their food.

They have broad, flat faces, widest just below the eyes, and their complexion when relieved of dirt and smoke approaches more nearly to white than that of their copper-coloured neighbours the Red Indians. Most of the men are rather under the medium English size, but they cannot be said to be a dwarfish race. Their dress is admirably adapted to the severity of the climate. With their two pair of breeches, made of reindeer or seal-skin, the outer one having the hair outside and the inner one next the body, and their two jackets, of which the upper one is provided with a great hood; with their water-tight seal-skin boots, lined with the downy skins of birds, and their enormous gloves, they bid defiance to the severest cold, and, even in the hardest weather, pursue their occupations in the open air.

ESQUIMAUX IN HIS KAYAK.

The Esquimaux are very skilful in building their huts, which they construct of slabs of frozen snow. They clear away a space of snow down to the ice, which forms the floor of their dwelling, and the frozen snow which they take out forms the walls. Two men generally work together, and when the dome-shaped roof is completed, the one who has been working inside cuts a low door and crawls out. The walls, being only three or four inches in thickness, admit sufficient light. Though these huts are built of such fragile materials, they are very durable, for the wind has but little effect upon the dome-like roof, and the snow is not thawed until the sun has acquired very considerable power. Of course a strong fire cannot be made within, but such is not needed by the Esquimaux, for the lamp of train-oil is powerful enough to dry his wet clothes when he returns from hunting, and the crowding of several people into so small a space keeps up the temperature.

ESQUIMAUX WATCHING A SEAL HOLE.

The most ingenious invention of the Esquimaux is the '**kayak**,' a boat large enough only for one person. It consists of a long, light, and narrow frame of wood or walrus bone, is covered with seal-skin so as to be quite water-tight, and but one circular hole is left in the centre. In this the Esquimaux sits with outstretched legs, and binds a sack so tightly round his middle, that even in a heavy sea not a drop of water can penetrate into the boat. Striking with his paddle first to the right and then to the left, he flies like an arrow over the water.

'The weapons of the Esquimaux, and their various fishing and hunting implements, likewise show great ingenuity and skill. Their oars are tastefully inlaid with walrus teeth; they have several kinds of spears or darts, adapted to the size of the various animals which they hunt; and their elastic bows, strongly bound with strings of seal-gut, drive a six-foot arrow with unerring certainty to a distant mark. To bring down a larger animal, the shaft is armed with a sharp flint, or a painted bone.

'The harpoons and lances used in killing whales or seals have long shafts of wood or of the narwhal's tooth, and the barbed point is so constructed that, when the blow takes effect, it is left sticking in the body of the animal while the shaft attached to it by a string is disengaged from the socket, and becomes a buoy of wood. Knives, spear-points, and fish-hooks are made of the horns and bones of the deer, and the ribs of the whale are used in roofing huts, or in the construction of sledges.'

In summer they kill reindeer and the numerous sea-fowl such as swans, ducks, and geese. They depend, however, chiefly on the seal and walrus. These animals supply them with food, and from the bones, entrails, and hides they make a large number of articles which are essential both to their hunting and fishing.

li'-chen: a small cellular plant which does not flower.	**train-oil**: whale oil extracted from the blubber by boiling.

46. HUNTING THE WALRUS.

The Arctic **walrus** forms the nearest approach to the seals in the scale of creation, and is likewise better adapted for a marine life than for existence on dry land. But he is completely without fore teeth, and his grinders have a broad furrowed crown, like those of the herbivorous animals. This difference of teeth points to a difference of food, and while the seals are such voracious fish-eaters that Sir James Ross found no less than twenty-eight pounds of undigested fish in the stomach of a southern seal, the walrus lives principally on sea-weeds and molluscs.

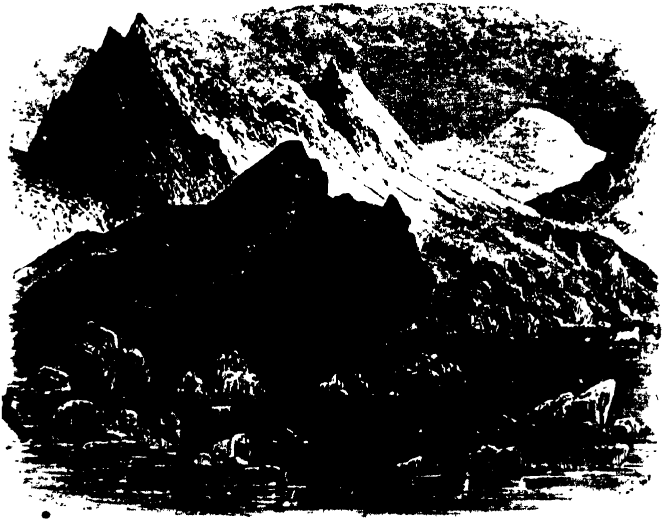
The walrus or sea-horse is one of the largest mammals known, as he sometimes grows to the length of eighteen feet, and measures twelve feet about the middle of the body. His form is very clumsy, having a small head, a strong neck, a thick body, and short legs, the hind feet uniting to a broad fin. With such a form, no one can wonder at the clumsiness of its movements on land. Admiral Beechey describes the gallop of a sea-horse as probably the most awkward motion exhibited by the animal tribe.

The upper lip, which is very thick, and indented or cleft into two large rounded lobes, furnished with thick yellow bristles, contributes also but little to its external beauty. From under this formidable-looking lip protrude two large and long tusks, growing, like those of the elephant, from the upper jaw, but bent downwards, not outward and upwards, as is the case with the latter. Their uses are also very different, for while the elephant employs his tusks in digging up roots, the walrus raises by their assistance his unwieldy body upon the ice-blocks and precipitous rocks where he loves to bask in the sun. Both animals use them, moreover, as formidable weapons, the former against the bounding tiger, the latter against the hungry ice-bear or the voracious shark.

In fine weather the walruses, like the seals, gather on the ice, where they may be seen in herds consisting occasionally of upwards of a hundred animals in each. Here they appear greatly to enjoy themselves, rolling and sporting about, and frequently making the air resound with their bellowing, which bears some resemblance to that of a bull.

Though the first movement of the walruses at the approach of danger is to seek the water, yet here, enraged by an unprovoked attack, they often become most formidable assailants. Beechey records a remarkable instance of this.

'One evening, while the "Dorothea" and "Trent" were at anchor in Magdalena Bay, Spitzbergen, several herds of these animals had crawled upon the ice to enjoy the fine weather and to rest themselves. The boats, properly equipped, and manned with some of the officers and seamen, pushed off in pursuit of them. The first herd which was selected disappointed the sportsmen, but another was so intent upon its gambols, that the sentinel absolutely forgot his duty, and several of the crew managed to effect a landing upon the ice without an alarm being given to the animals. As soon, however, as the first musket was fired, the affrighted group made such a desperate rush towards the edge of the ice that they nearly overturned the whole of the assailing party, purposely stationed there to intercept them. The seamen, finding this charge more formidable than they expected, were obliged to separate to allow their opponents to pass through their ranks: and being thus in their turn taken by surprise, they suffered them, almost unmolested, to



MAGDALENA BAY.

perform their somersaults into the sea. One, however, was desperately wounded in the head with a ball, and one of the men being determined if possible to secure his prey, resolutely struck his tomahawk into the animal's skull. But the enraged walrus, with a twist of its head, sent the weapon whirling in the air, and effected his escape into the sea.

'The seamen followed and pushed off in their boats; but the walrus, finding themselves more at home than on the ice, in their turn became the assailants. They rose in great numbers about the boats, snorting with rage, and rushing at the boats, which they tried to upset or stave in by getting their tusks over the gunwales. It was the opinion of the seamen that in this assault the walruses were led on by one animal in particular, a much larger and more formidable beast than any of the others, and they directed their efforts more particularly towards him; but he withstood all the blows of their tomahawks without flinching, and his tough hide resisted the entry of the whale lances. The herd was so numerous, and their attacks so incessant, that there was not time to load a musket. Fortunately the purser remembered that his gun was loaded, and snatching it up, he thrust the muzzle down the throat of the leader, and fired.

'The wound proved mortal, and the animal fell back amongst his companions, who immediately desisted from the attack, assembled round him, and in a moment quitted the boat, swimming away as hard as they could with their leader, whom they actually bore up with their tusks and kept from sinking.'

The valuable ivory of its tusks, which is more solid, finer grained, and whiter than that of the elephant, exposes the walrus to the attacks of man. The Esquimaux hunt it for the sake of its thick hide, from which they make harpoon lines and many other useful articles, and for its flesh and blubber, which form one of their chief sources of food. *From Hartwig's 'Polar World.'*

as-sail'-ant: one who makes an attack.
e-quip'-ped: fitted out: made quite ready.
gun'-wale (*gun'-le*): the upper part of the sides of a boat.
herb-iv'-or-ous: eating herbs only.
lobe: a division or part, thus the lobe of the ear is the lower part.
mol'-luscs: animals having soft fleshy bodies and no bony framework or skeleton.
sen'-tin-el: one who is placed on guard.

47. THE INHABITANTS OF THE SEA: BIRDS. (II.)

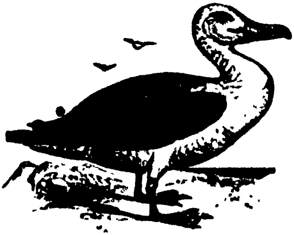
ANOTHER great family of birds is widely spread over the whole surface of the ocean, and comprises the gulls, the sea-swallows, the petrels and the albatross.

All the birds of this tribe have a powerful flight, and are distinguished by the easy grace of their motions, striking the air at long intervals with their wings, and generally gliding or soaring with outstretched pinions. Their form is handsome and well-proportioned, but their mode of life does not correspond with their beauty, as they are all ill-famed for their predatory habits and insatiable voracity.

The **stormy petrel** seems to belong to every sea. It is about the size of a swallow, and in its general appearance and flight it is not unlike that bird. Although the smallest web-footed bird known, it braves the utmost fury of the tempest, often skimming with incredible velocity the trough of the waves, and sometimes gliding rapidly over their snowy crests. Like all of its kind, it lives almost constantly at sea, and seeks during the breeding season some lonely rock, where it deposits in some fissure or crevice its solitary egg. The mode of life of the petrels corresponds but little with their external beauty; they are in fact the crows of the ocean, and live upon the dead animal substances floating on its surface.

The **albatross** is the monarch of the high seas; the picture of a hero, who, 'under every storm of adverse fortune, preserves the immovable constancy of an undaunted heart.' Proud and majestic, he swims along in his own native element, and without ever touching the water with his pinions, rises with the rising billow, and falls with the falling wave. It is truly wonderful how he bids defiance to the fury of the storm, and how quietly he faces the gale. 'He seems quite at home,' say the sailors; and indeed this expression is perfectly characteristic of his graceful ease as he hovers over the agitated ocean.

The albatross exceeds the swan in size; he attains a weight of from 12 lbs. to 28 lbs., and extends his wings from ten to thirteen feet. His plumage is white and black, harmonising with the wave crest and the storm-cloud. For weeks and months together he is seen to follow the course of a ship; but 'the time he can remain on the wing seems to have been much exaggerated, for although, like the gull and the petrel, he is no diving bird, he swims with the greatest ease; and notwithstanding the enormous length of his pinions, knows well how to rise again into the air. He is indeed unable to take wing from a narrow deck, but when he wishes to rise from the sea, he runs along flapping the waters until he has acquired the necessary impetus, or meets with a wave of sufficient height, from whose lofty crest he starts as from a rocky pinnacle, and resumes his extensive flight over an immense expanse of ocean.'


WANDERING ALBATROSS.

The regions of storms—the Cape of Good Hope and

Cape Horn—are his favourite resorts, and all travellers know that the southern point of Africa is not far distant as soon as the albatrosses show themselves in larger numbers. These birds are the vultures of the ocean; their crooked sharp-edged beak is better adapted to lacerate a lifeless prey, than to seize upon the rapid fish as it darts swiftly along below the surface of the waters: From a vast distance they smell the floating carcass of a whale, and soon alight in considerable numbers upon the giant carrion.

THE STORMY PETREL.

A THOUSAND miles from land are we
Tossing about on the roaring sea;
From billow to bounding billow cast,
Like fleecy snow on the stormy blast:
The sails are scattered about like weeds,
The strong masts shake like quivering reeds;
The mighty cables and iron chains,
The hull which all earthly strength disdains,
They strain and they crack: and hearts of stone,
Their natural hard proud strength disown.

Up and down! up and down!
From the base of the wave to the billows' crown,
Amidst the flashing and feathery foam,
The stormy petrel finds a home;
A home,—if such a place can be
For her who lives on the wide, wide sea,

On the craggy ice, in the frozen air,
And only seeking her rocky lair
To warn her young, and teach them to spring,
At once o'er the waves on their stormy wing!

O'er the deep! o'er the deep!
Where the whale, and the shark, and the sword-fish
sleep!
Outflying the blast and the driving rain,
The petrel telleth her tale in vain:
For the mariner curseth the warning bird,
Who bringeth him news of the storm unheard:
Ah! thus does the prophet of good or ill
Meet hate from the creatures he serveth still;
Yet, he never falters; —so, petrel! spring
Once more o'er the waves on thy stormy wing.

BARRY CORNWALL.

in-sa'-ti-able: that is never satisfied; voracious.	**la'-cer-ate**: tear in pieces.
	pre'-da-to-ry: thieving; plundering.

THE STORMY PETREL.

48. HUDSON'S VOYAGES.

In the year 1627 Henry Hudson made the first attempt to steer right on to the pole,* and to cross to India over the axis of the globe. He reached the northern extremity of Spitzbergen, but all his attempts to penetrate deeper into the polar ocean were baffled by the mighty ice-fields that opposed his progress. But though he failed in his undertaking to sail through the region of eternal winter to the spicy groves of India, yet the numerous walruses and seals he had seen basking on the coast of Spitzbergen opened such cheering prospects of future profit, that the 'Muscovy Company,' which had fitted out the expedition, was by no means discontented with the issue of his voyage.

Three years after we find the gallant Hudson once more attempting to discover the north-west passage in a vessel of fifty-five tons, provisioned for six months. The crew which he commanded was unfortunately utterly unworthy of such a leader, and quailed as soon as they had to encounter the fog and ice-fields of the Frozen Ocean.

'And now there came both mist and snow,
And it grew wondrous cold;
And ice mast-high came floating by,
As green as emerald.

And through the drifts the snowy clifts
Did send a dismal sheen,
Nor shapes of men nor beasts we ken,
The ice was all between.'

But, in spite of the murmurs and repinings of his faint-hearted followers, the dauntless commander pressed on through the strait which bears his name, until at last his little bark emerged into a boundless deep blue sea. Hudson's Bay lay before him, but the delighted discoverer was happy in the belief that the grand object of his voyage was attained, and the shortest road to India laid open to the mariners of England. It was about the beginning of August, and the spiritless crew, considering the passage accomplished, urged an immediate return; but Hudson was determined on completing the adventure, and wintering if possible on the sunny shores of India.

Three months long he continued tracking the coasts of that vast northern Mediterranean, now for the first time explored by civilised man, vainly hoping to see a new channel opening to the west, until at length November came and imprisoned his small vessel in adamantine fetters. A long and dreary winter awaited the ice-bound seamen, with almost exhausted provisions, and unfortunately without that heroic patience and serene concord which had sustained the sufferings of Barentz and his companions.

It must indeed have been a melancholy winter for poor Hudson, solitary and friendless among scowling ruffians, hating him as the cause of their bitter misery; But spring came at last with its consolatory sunshine, and hope once more dawned in his tortured breast. The ship is again afloat, and on June 21, 1611, the captain comes forth from his cabin, refreshed by the sleep of a quiet conscience, and strong in body and mind to meet the duties of the day. But as he steps on deck his arms are suddenly pinioned, and he finds himself in the power of a mutinous crew. He looks around for some trace of sympathy, but hatred meets him in every eye. Inquiry, remonstrance, entreaty, command, all alike fail to move their stubborn resolution, and now Hudson resigns himself bravely to his fate, with all the quiet dignity of a noble nature, and looks calmly at the ominous preparations going forward. A small open boat is in waiting, and into this he is lowered, some powder and shot and the carpenter's box come next, followed by the carpenter himself, a strong brave fellow, the captain's *one* devoted adherent among the rebellious crew; the sick and infirm complete the unfortunate cargo. A signal is given, the boat is cast adrift, and soon the last faint cry for mercy expires in the breeze which carries the vessel onwards on its homeward course.

Thus perished the high-minded Hudson, without further tiding or trace, on the scene of his glory; but the vengeance of heaven soon overtook the ringleaders of that dark conspiracy. Some fell in a fight with the Esquimaux, and others died on the homeward voyage, which was performed under the extremity of famine. Whatever horrors may have attended the last moments of Hudson, his sufferings were less, for his conscience was free from guilt.

Barents: a Dutch navigator who was one of the first to spend a winter frozen up in the Arctic Ocean.

ad-am-an'-tine: hard as adamant; that cannot be broken.

Muscovy Company: a company which was formed in the reign of Queen Mary to trade with Russia.

pin'-ion-ed: arms tightly fastened behind.

49. THE NORTH-WEST PASSAGE.

In spite of the unsuccessful efforts of a Frobisher, a Davis, a Hudson, and a Baffin, England had never given up the hope of discovering a northern passage to India, either direct across the Pole, or round the coast of North America, but during the continental war she indeed had little leisure to prosecute discoveries in the Arctic Ocean. Not long after the conclusion of peace (1818) two expeditions were sent out for that purpose.

Captain Buchan, with the ships 'Dorothea' and 'Trent,' sailed with instructions to proceed in a direction as due north as might be practicable through the Spitzbergen Sea; but, having after much difficulty gained lat. 80° 34′ north in that polar archipelago, he was obliged speedily to withdraw and try his fortune off the western edge of the pack. Here, however, a tremendous gale, threatening every moment to crush the ships between the large ice-blocks heaving and sinking in the roaring billows, induced the bold experiment of dashing right into the body of the ice; a practice which has been resorted to by whalers in extreme cases, as their only chance of escaping destruction.

'While we were yet a few fathoms from the ice,' says Admiral Beechey, the eloquent eye-witness and narrator of the dreadful scene, 'we searched with much anxiety for a place that was more open than the general line of the pack, but in vain; all parts appeared to be equally impenetrable, and to present one unbroken line of furious breakers, in which immense pieces of ice were heaving and subsiding with the waves.

'No language, I am convinced, can convey an adequate idea of the terrific grandeur of the effect now produced by the collision of the ice and the tempestuous ocean. The sea violently agitated, and rolling its mountainous waves against an opposing body, is at all times a sublime and awful sight; but when, in addition, it encounters immense masses, which it has set in motion with a violence equal to its own, its effect is prodigiously increased. At one moment it bursts upon these icy fragments, and buries them many feet beneath its wave, and the next, as the buoyancy of the depressed body struggles for reascendency, the water rushes in foaming cataracts over its edges; whilst every individual mass, rocking and labouring in its bed, grinds against and contends with its opponent until one is either split with the shock or upheaved upon the surface of the other.

'At this instant, when we were about to put the strength of our little vessel in competition with that of the great icy continent, and when it seemed almost presumption to reckon on the possibility of her surviving the unequal conflict, it was gratifying in the extreme to observe in all our crew the greatest calmness and resolution. If ever the fortitude of seamen was fairly tried, it was on this occasion; and I will not conceal the pride I felt in witnessing the bold and decisive tone in which the orders were issued by the commander of our little vessel (the since so far-famed and lamented Franklin), and the promptitude and steadiness with which they were executed by the crew.

'We were now so near the scene of danger as to render necessary the immediate execution of our plan, and in an instant the labouring vessel flew before the gale. Each person instinctively secured his own hold, and with his eyes fixed upon the masts, awaited in breathless anxiety the moment of concussion. It soon arrived; the brig, cutting her way through the light ice, came in violent contact with the main body. In an instant we all lost our footing, the masts bent with the impetus, and the cracking timbers from below bespoke a pressure which was calculated to awaken our serious apprehensions. The vessel staggered under the shock, and for a moment seemed to recoil; but the next wave, curling up under her counter, drove her about her own length within the margin of the ice, where she gave one roll and was immediately thrown broadside to the wind by the succeeding wave. This unfortunate occurrence prevented the vessel from penetrating sufficiently far into the ice to escape the effect of the gale, and placed her in a situation where she was assailed on all sides by battering rams, if I may use the expression, every one of which contested the small space which she occupied, and dealt such unrelenting blows that there appeared to be scarcely any possibility of saving her from foundering. Literally tossed from piece to piece, we had nothing left but patiently to abide the issue, for we could scarcely keep our feet, much less render any assistance to the vessel. The motion indeed was so great that the ship's bell, which in the heaviest gale of wind had never struck of itself, now tolled so continually that it was ordered to be muffled.'

By setting more head-sail, though at the risk of the masts, already tottering with the pressure of that which was spread, the vessels, splitting the ice and thus effecting a passage between the pieces, were at length released from their perilous situation, but the 'Dorothea' was found to be completely disabled. A short time at Fair-haven in Spitzbergen was spent in necessary repairs, and even then she was unfit for any farther service than the voyage to England.

ap-pre-hen'-sions: fears.
battering rams: huge engines of war, consisting of large wooden beams with which armies in olden times tried to break down the walls and gates of a town.
nar-ra'-tor: the one who tells the story.

50. THE INHABITANTS OF THE SEA: BIRDS. (III.)

THE family of the **grebes** and **divers** is much like the duck tribe in the order of creation, but is distinguished by a long conical bill and the position of the legs, which are placed so far back towards the tail, that when the bird leaves the water it is obliged to stand nearly erect to preserve its equilibrium. The foot in the grebes is only partially webbed, the toes being merely finned; but the divers are completely web-footed, like the duck. These latter do honour to their name, being most expert and indefatigable divers, remaining down sometimes for several minutes, and swimming rapidly under the water.

AUK.

Another family, comprising the **guillemots, auks, razor-bills,** and **puffins,** is in form of body very similar to the divers; the legs, which are short and thick, are inserted very far back, and give a still more erect carriage to the bird when on shore. The wings are short and small in proportion to the bulk of the body. The auks are strictly sea-birds, and nestle on its borders, breeding in caverns and rocky cliffs, and laying only one large egg. They obtain their food by diving, at which they are very expert. They are of social habits, and congregate in vast flocks on the rocky islets and headlands of the northern coasts.

In the **penguins** of the southern hemisphere, the shortness of wing and aptitude for swimming and diving are still more conspicuous than in the auks of the northern region. In the water, the penguin makes use of its small featherless wing-stumps as paddles; on land, as fore feet, with whose help it scales so rapidly the grass-grown cliffs, as to be easily mistaken for a quadruped. Other sea-birds generally keep part of their body out of the water while swimming; but this is not the case with the penguin, whose head alone appears above the surface. How much it feels itself at home on the waters may be inferred from the fact that Sir James Ross once saw two

PUFFIN.

PENGUINS.

penguins paddling away a thousand miles from the nearest land.

On many uninhabited islands in the higher latitudes of the southern hemisphere, this strange bird is met with in incredible numbers. The Falkland Islands swarm with penguins. In summer and autumn these strange birds leave their burrows early in the morning, and launch into the sea for fishing. After having filled their capacious stomachs, they waddle on shore, and remain for a time congregated on the strand, raising a dreadful clamour; after which they retire to enjoy a noon-tide sleep among the high grass or in their burrows. In the afternoon the fishing recommences. It may be imagined how the neighbouring seas must abound with fish to be able to nourish such multitudes of penguins, when we consider that the stomach of one of these birds is capable of holding more than two pounds.

To the pelican tribe, which is generally distinguished by a surface of naked skin about the throat, capable of being considerably widened, and serving as a pouch for the reception of unswallowed food, belong among others the **cormorant,** the **frigate-bird,** and the **gannet** or soland-goose. All these birds are of much more active habits than the last-named family, with bodies of more shapely form, more ample wings, and a stronger flight.

COMMON CORMORANT.

The common **cormorant,** with his long bill, bent at the point, his black livery, and yellowish chin-pouch, is a most disagreeable comrade. In China the cormorant is tamed and employed in fishing.

FRIGATE-BIRD.

The **frigate-bird** hovers over the tropical waters. Its singularly easy and graceful flight affords all the charm of variety. Sometimes it is seen balanced in mid-air, its wings spread, but apparently motionless, its long forked tail expanding and closing with a quick alternate motion, and its head turned inquisitively downwards; sometimes it wheels rapidly, and darts to the surface of the water in pursuit of prey; and then again it soars so as to be lost to vision. Sometimes it is seen 400 leagues from land. Its expanded pinions measure fourteen feet from end to end. Being unable to swim or dive, it seizes the flying-fish as it darts from the sea, or it compels fishing-birds to disgorge their prey.

The **gannet** or soland-goose haunts the Bass Rock, a steep islet in the Firth of Forth, whose precipices are painted with dazzling stripes of white guano, the product of the inconceivable number of birds which settle upon the weather-beaten ledges. Its mode of fishing is particularly graceful. Rapidly skimming the surface of the sea, as soon as it spies a fish swimming below, it rises perpendicularly over the spot, and then, suddenly folding its wings, drops head-foremost on its prey swifter than an arrow, and with almost unerring aim. The gannet feeds also on Lundy Island, on Ailsa Craig, on the coast of

Ayrshire, on the Island of St. Kilda, and hardly anywhere else in Europe.

Ailsa Craig: a solitary rock at the entrance to the Firth of Clyde.

con-spi'-cu-ous: easily seen.

dis-gorge': give up.

eq-ui-li'-bri-um: balance.

in-quis'-i-tive-ly: seeking something.

St. Kilda: an island farther west than the Hebrides; the inhabitants live almost entirely by catching sea-birds.

51. THE NORTH-WEST PASSAGE: SIR JOHN FRANKLIN.

ON May 26, 1845, Sir John Franklin, now in the sixtieth year of his age, and Captain Crozier, sailed from England, to make a new attempt at the north-west passage. Never did stouter vessels than the 'Erebus' and 'Terror,' well-tried in the Antarctic Seas, carry a finer or more ably commanded crew; never before had human foresight so strained all her resources to ensure success; and thus, when the commander's last despatches (July 12), previous to his sailing to Lancaster Sound, arrived in England, no one doubted but that he was about to add a new and brilliant chapter to the history of Arctic discovery.

His return was confidently expected towards the end of 1847; but when the winter passed and still no tidings came, the anxiety at his prolonged absence became general, and the early part of 1848 witnessed the beginning of a series of searching expeditions fitted out at the public cost, or by private munificence, on a scale exceeding all former examples. However, they all failed in the object of their search. In the year 1850, no less than twelve ships sailed forth, some to Behring's Straits, some to the sounds leading from Baffin's Bay. Other expeditions followed in 1852 and 1853, and though none of them succeeded in the object of their search, yet they enriched the geography of the Arctic World with many interesting discoveries.

Years thus passed without bringing any tidings of the 'Erebus' and 'Terror' since the discovery of their first winter-quarters, until at last, in the spring of 1854, Dr. Rae, of the Hudson's Bay Company, fell in with a party of Esquimaux, who informed him that in the spring of 1850 some of their countrymen on King William's Island had seen a party of white men making their way to the mainland. None of them could speak the Esquimaux language intelligibly, but by signs they gave them to understand that their ships had been crushed by ice, and that they were now going to where they expected to find deer to shoot. At a later date of the same season, but before the breaking up of the ice, the bodies of some thirty men were discovered on the continent a day's journey from Back's Great Fish River, and five on an island near it. Some of the bodies had been buried (probably those of the first victims of famine), some were in a tent, others under the boat which had been turned over to form a shelter, and several lay scattered about in different directions. Of those found on the island one was supposed to have been an officer, as he had a telescope strapped over his shoulder and his double-barrelled gun lay underneath him. Some silver spoons and forks, a round silver plate, engraved 'Sir John Franklin, K.C.B.,' a star or order, which Dr. Rae purchased of the Esquimaux, corroborated the truth of their narrative.

Thus it was now known how part of the unfortunate mariners had perished, but the fate of the expedition was still enveloped in mystery. What had become of the ships and of the greater part of their crews?

To solve at least this mournful secret, his noble widow resolved to spend all her available means—since Government would no longer prosecute the search—and with the assistance of her friends, but mostly at her own expense, fitted out a small screw steamer, the 'Fox,' which the gallant M'Clintock, already distinguished in perilous Polar voyages, volunteered to command. Another Arctic officer, Lieutenant Hobson, likewise came forward to serve without pay.

At first it seemed as if all the elements had conspired against their success, for in the summer of 1857 the floating ice off Melville Bay, on the coast of Greenland, seized the 'Fox,' and after a dreary winter, various narrow escapes, and eight months of imprisonment, carried her back nearly 1,200 geographical miles, even to 63½° N. lat. in the Atlantic.

At length, on April 25, 1858, the 'Fox' got free, and sailed into Barrow Strait. Finding Franklin Channel obstructed with ice, she then turned back, and steaming up Prince Regent Inlet, arrived at the eastern opening of Bellot's Strait. Here the passage to the west was again found blocked with ice, and after five ineffectual attempts to pass, the 'Fox' at length took up her winter-quarters in Port Kennedy, on the northern side of the strait.

On his first sledge excursion in the following spring, M'Clintock met, on the south-west coast of Boothia, with a party of Esquimaux, who informed him that some years back a large ship had been crushed by the ice out in the sea to the west of King William's Island, but that all the people landed safely.

Meeting with the same Esquimaux on April 20, he learned, after much anxious inquiry, that besides the ship which had been seen to sink in deep water, a second one been forced on shore by the ice, where they supposed ill remained, but much broken. They added that it in the fall of the year—that is, August or September hen the ships were destroyed; that all the white people nt away to the Great Fish River, taking a boat or boats h them, and that in the following winter their bones re found there.

Meanwhile Lieutenant Hobson, who was exploring th another sledge party the north-western coast of King illiam's Land, had made the still more important disvery of a record, giving a laconic account of the Franklin pedition up to the time when the ships were lost and andoned. It was found on May 6 in a large cairn at oint Victory. From it we now know that Sir John anklin died on June 11, 1847, having completed—two onths before his death—the sixty-first year of an active, entful, and honourable life. On April 22, 1848, the ips were deserted, having been beset since Sept. 12, 846. The officers and crew, consisting of 105 souls, nder the command of Captain Crozier, landed with the ntention of starting for Back's Fish River, which, as we ave seen, they were never destined to reach.

Thus all doubts about Sir John Franklin's fate were t length removed. He at least had died on board his hip, and been spared the miserable end of his comrades, s they fell one by one in the dreary wilderness.

cairn: a large heap of stones to mark a spot.
des-patch'-es: budgets of news or letters.
in-tel'-li-gib-ly: so as to be understood.
K.C.B.: Knight Commander of the Bath.
la-con'-ic: expressed clearly but in few words.
mu-ni'-fic-ence: benevolence; kindness.

52. THE ANTARCTIC OCEAN.

The Antarctic Ocean lies within the Antarctic Circle and is a continuation of the Atlantic, Pacific, and Indian Oceans to the south. Hence it forms a girdle of water all round the globe, and it is here that we are able to observe most clearly the way in which the great tidal waves are caused by the attraction of the moon. We know but very little of this ocean as compared with the accurate observations that have been taken in the other oceans. The Arctic Ocean has been explored over and over again by daring seamen during the last two hundred years. For long it was the dream of English navigators to discover a north-west passage to India by way of North America. And when, after deeds of heroism which read like tales of romance, a passage was discovered, it was found that it is useless as a highway for ships, for during the greater part of the year it is completely blocked with ice. Still though the immediate object of their search proved useless when it was found, the men who nobly risked their lives in these frozen seas added largely to our stock of knowledge, and thus it is that while the Arctic Seas have been penetrated to within a few hundred miles of the pole the Antarctic Ocean remains almost entirely unknown.

This is also largely due to the fact that the cold reaches nearer to the equator in these southern seas than in the northern, for here the vast ice-field which guards the Polar land reaches ten degrees nearer to the equator than it does in the Arctic Seas. Nearly all we know about this ocean has been taught us by

Sir James Ross, who penetrated as far as 78° south latitude, whereas no other voyager has gone beyond latitude 72° south.

He discovered a steep coast with glaciers stretching far out into the sea. The land appeared to be spread out towards the pole. Other navigators have also touched the land at various points, and Wilkes, the commander of a United States exploring expedition, followed the coast-line for a distance of about 1,500 miles. How far this and stretches we can only guess at, but from the fact hat the coast has been touched in every direction it seems highly probable that these points are merely the outer portions of a large island-continent surrounding the pole. This view is strengthened by the fact that the Antarctic Ocean is shallow, and its bed in every direction rises towards the south. The greatest depth found by the Challenger' expedition was nearly 12,000 feet, whereas Ross, who penetrated much nearer the pole, got no soundings of over 3,000 feet.

Ross discovered a magnificent mountain-chain, of which the most conspicuous object was an active volcano reaching to a height of 12,000 feet. This he named after one of his ships, the 'Erebus.' He had the good fortune to witness an eruption of this splendid volcano. The enormous columns of flame and smoke, rising 2,000 feet above the mouth of the crater, combined with the snow-white mountain range and the deep-blue ocean to form a magnificent scene. An extinct volcano to the eastward was found to be over 10,000 feet in height, and in honour of his second ship was named Mount Terror. A brilliant mantle of snow swept down the sides of both these giants of the south, and projected a perpendicula icy cliff several miles into the sea.

Ross would gladly have penetrated still farther to th south, but all his efforts were baffled by a vast barrier o ice, forming an uninterrupted wall 450 miles in length and rising in some parts to a height of 180 feet above th sea-level.

The icebergs in the Antarctic Ocean differ in shap from those of the Arctic Ocean. In the latter the icebergs are of most irregular shape, whereas in the former they are huge flat-topped and wall-sided masses which have been broken off from vast glaciers. A belt of sea several hundreds of miles in width encircling the globe is covered with these floating masses, which are carried forward by the currents for thousands of miles, and advance far into the South Atlantic before they finally succumb to the rays of the sun. It is owing to their presence that the Peruvian current, which sweeps along the west coast of South America, is so much colder than the neighbouring waters.

This southern polar region is even more desolate than the northern. Here there are no grizzly bears or arctic foxes. The only life is that of seals and walruses, sea-birds and penguins. There are no Esquimaux to lend a helping hand to shipwrecked sailors. Not a human being lives throughout the vast extent. Fierce storms sweep across its surface, and its icebound coast is guarded for hundreds of miles by masses of ice which lie so close together that it is a work of the greatest difficulty and danger for a ship to try to force a passage.

extinct volcano: one in which the fires have died out.

gla'-ci-er: a river of solid ice, slowly moving to the sea.

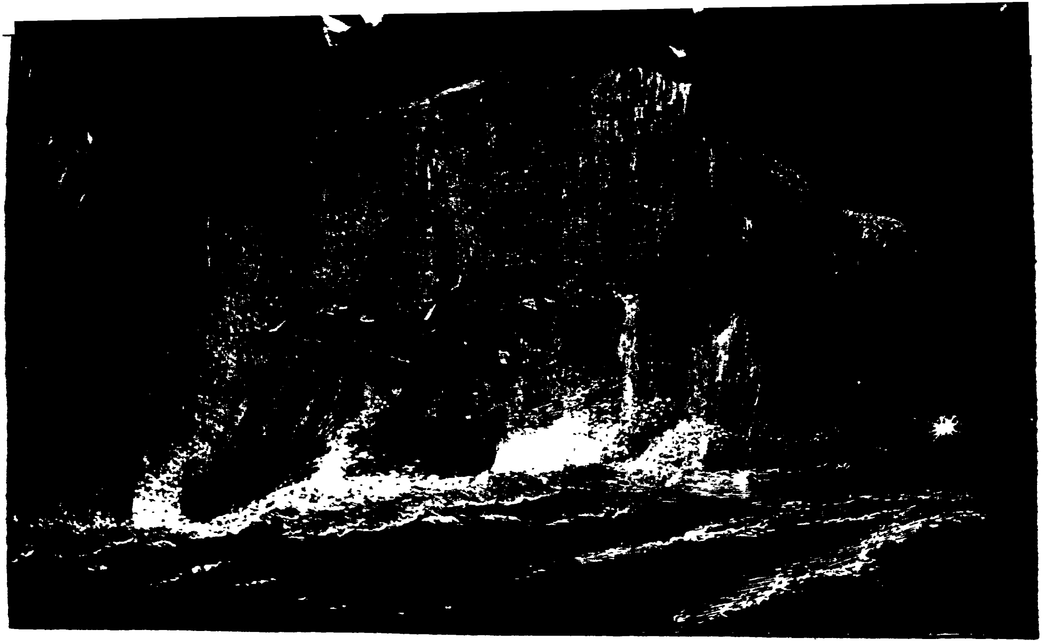
3. SIR JAMES ROSS IN THE ANTARCTIC OCEAN.

R people had hardly completed these operations, n a large berg was seen ahead and quite close; the was immediately hauled to the wind on the port , with the expectation of being able to weather it; but at this moment the "Terror" was observed running wn upon us, under her topsail and foresail; and as it s impossible for her to clear both the berg and the Erebus" collision was inevitable. We instantly hove all ack to diminish the violence of the shock; but the con- ssion, when she struck us, was such as to throw almost ery one off his feet; our bowsprit, foretopmast, and her smaller spars were carried away, and the ships nging together entangled by their rigging, and dashing ainst each other with fearful violence, were falling down on the weather face of the lofty berg under our lee, ainst which the waves were breaking and foaming to ar the summit of its perpendicular cliffs.

'Sometimes the "Terror" rose high above us, almost posing her keel to view, and again descended, as we in ur turn rose to the top of the wave, threatening to bury er beneath us, whilst the crashing of the breaking pper-works and boats increased the horror of the scene. rovidentially the ships gradually separated before we rifted down amongst the foaming breakers, and we had he gratification of seeing the "Terror" clear the end of he berg, and of feeling that she was safe.

'But she left us completely disabled; the wreck of the pars so encumbered the lower yard, that we were unable o make sail, so as to get headway on the ship; nor had we room to wear round, being by this time so close to th berg that the waves, when they struck against it, thre back their spray into the ship. The only way left to u to extricate ourselves from this awful and appalling situation was by resorting to the hazardous expedient of stern board, which nothing could justify during such gale but to avert the danger which every moment threatened us of being dashed to pieces. The heavy rolling o the vessel, and the probability of the masts giving wa each time the lower yard-arms struck against the cliffs which were towering high above our mastheads, rendere it a service of extreme danger to loose the mainsail; bu no sooner was the order given than the daring spirit o the British seaman manifested itself—the men ran up th rigging with as much alacrity as on any ordinary occasion; and, although more than once driven off the yard they after a short time succeeded in loosing the sail.'

'Amidst the roar of the wind and sea, it was difficul both to hear and to execute the orders that were given so that it was three-quarters of an hour before we could ge the yards braced by, and the maintack hauled on boar sharp aback—an expedient that perhaps had never befor been resorted to by seamen in such weather; but it had the desired effect; the ship gathered sternway, plunging her stern into the sea, and with her lower yard-arms scraping the rugged face of the berg, we in a few minutes reached its western termination; the "under-tow," as it is called, or the reaction of the water from its vertical cliffs, alone preventing us being driven to atoms against it. No sooner had we cleared it than another was seen directly astern of us, against which we were running;



THE 'EREBUS' AND 'TERROR' AMONG ICEBERGS.

and the difficulty now was to get the ship's head turned round and pointed fairly through between the two bergs, the breadth of the intervening space not exceeding three times her own breadth. This, however, we happily accomplished; and in a few minutes, after getting before the wind, she dashed through the narrow channel between two perpendicular walls of ice, and the foaming breakers which stretched across it, and the next moment, we were in smooth water, under its lee. The "Terror's" light was immediately seen and answered; she had rounded to waiting for us, . . . and, as soon as day broke, we had the gratification of learning that she had not suffered any serious damage.'—*From Hartwig's 'Polar World.'*

ap-pall'-ing: dreadful; fearful.
a stern board: to force the ship stern first through the sea.
con-cuss'-ion: the shock of a heavy blow.
gathered stern-way: began gradually to move astern; very rarely tried in a sailing-ship.
grat-i-fi-ca'-tion: pleasure.
hove all aback: so set the sails that they felt the wind upon that side of them that is usually away from the wind.
vert'-ic-al: upright; pointing to the centre of the earth.
yard-arm: the *yards* are the poles stretched across a ship's mast, and to which the sails are fastened; the arm is the outer extremity of the yard.

54. THE ANCIENT MARINER NEAR CAPE HORN.

THE ship was cheer'd, the harbour clear'd;
Merrily did we drop
Below the kirk, below the hill,
Below the lighthouse top.

The sun came up upon the left,
Out of the sea came he!
And he shone bright, and on the right
Went down into the sea.

And now the storm-blast came, and he
Was tyrannous and strong:
He struck with his o'ertaking wings,
And chased us south along.

With sloping masts and dipping prow,
As who pursued with yell and blow
Still treads the shadow of his foe,
And forward bends his head,
The ship drove fast, loud roar'd the blast,
And southward aye we fled.

And now there came both mist and snow,
And it grew wondrous cold:
And ice, mast-high, came floating by,
As green as emerald.

And through the drifts the snowy clifts
Did send a dismal sheen:
Nor shapes of men nor beasts we ken—
The ice was all between.

The ice was here, the ice was there,
The ice was all around;
It crack'd and growl'd, and roar'd and howl'd,
Like noises in a swound!

At length did cross an albatross,
Thorough the fog it came;
As if it had been a Christian soul,
We hail'd it in God's name.

It ate the food it ne'er had ate,
And round and round it flew;—
The ice did split with a thunder-fit;
The helmsman steer'd us through!

And a good south wind sprung up behind;
The albatross did follow,
And every day, for food or play,
Came to the mariner's hollo!

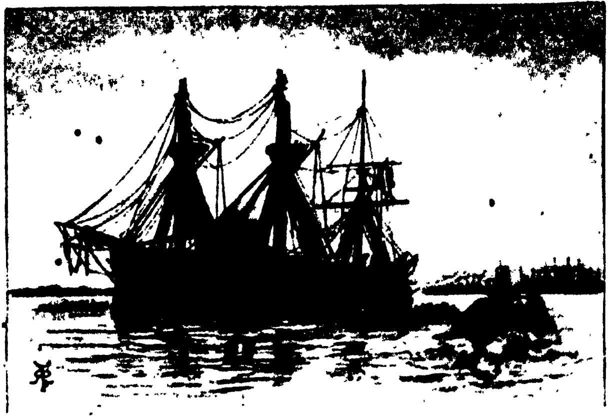
In mist or cloud, on mast or shroud,
It perch'd for vespers nine,
Whiles all the night, through fog-smoke white,
Glimmer'd the white moonshine.

S. T. Coleridge.

This is an extract from a poem which relates the adventures in a voyage round the world by a sailor whose brain has been touched by the hardships which he has undergone. The moral of the whole story is ned up in these lines from it:

He prayeth best, who loveth best
All things both great and small;
For the dear God who loveth us,
He made and loveth all.

al'-ba-tross: a large black-and-white bird found over the southern ocean.
kirk: a church.
ken: know.
prow: the bow.
sheen: shine.
swound: a swoon.



55. THE STARRY HEAVENS.

If we look at the heavens on a clear night we see that the sky is studded with bright points. Some of these shine forth very brightly, others are not so bright, while there are still others that can hardly be discerned with the naked eye. Stretching across the heavens is a soft luminous band, which when examined through the telescope appears as a myriad of bright points. This appearance is called the Milky Way, and is really a vast number of stars so far away that separate stars cannot be seen, and their united light causes the luminous appearance we have spoken of.

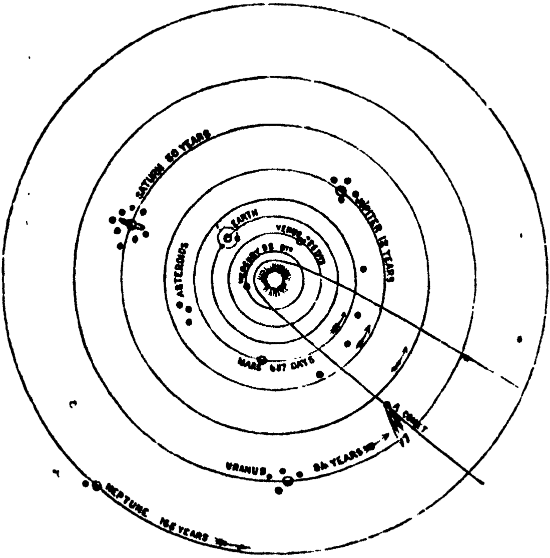
We generally speak of these bright points in the heavens as the stars, and we also speak of them as being countless. Countless they truly are, but the number which we can see on a clear night without the aid of a telescope is only about three thousand, whereas by the aid of a powerful glass that number may be increased to many millions. If we watched the stars night by night, we should soon observe that a few of them changed their place in the heavens, while all the rest seemed to be fixed. The latter are called the fixed stars, because they always appear in the same place in the sky. In fact if we could regard the sky as a vault of solid material, the stars appear as if they were rigidly stuck on the interior of the vault.

The former are named planets, from a Greek word meaning a wanderer, because they move about in the heavens. The word planet is usually applied to a very special group of heavenly bodies, for though they are so called because they are observed to move among the stars, yet there are other celestial bodies which are also wanderers, such as the moon and the comets.

In looking at the heavenly bodies through a telescope a very important difference may be noticed. No matter how strong may be the power of the glass, the stars appear always as points, though when seen in this way they appear more brilliant. But the planets appear as circular discs, and their surface may be examined. The reason for this difference is that the planets are nearer to the earth than the stars. Hence we see that an observer will note two marked differences between the planets and the stars. He will notice that whereas the former move in their courses through the heavens and present the appearance of a circular disc, the latter are always fixed points.

The planets are soon counted, for there are only five which can be seen easily with the unaided eye, and there are two others which may be seen by the help of a glass. Hence it follows that of all the heavenly bodies, the immense majority are fixed stars. The first feature to be noticed about the stars is the different degrees of brightness, and this has been used as a basis for classifying them. About twenty of the brightest stars are said to be of the **first magnitude**. The brightest star in the whole heavens is named Sirius. Next in order to those of the first magnitude come those of the **second magnitude**. Of these we may point out examples which are familiar to many, the four brightest stars in the group, or constellation, which is often called the Great Bear. The stars immediately below those of the second magnitude in brightness are called stars of the **third magnitude**, and so on down to the very smallest stars that can be seen in the most powerful telescopes.

The fainter the stars, the more numerous are they. Though there are but twenty stars of the first magnitude, there are 142,000 stars of the ninth magnitude. Hence we see that of the total number of the stars, only a comparatively small number are visible to the unaided eye. Stars of the fifth magnitude are faint, those of the sixth are very faint, and it requires a remarkably good vision to perceive stars of the seventh magnitude.



Now the question arises as to what these stars may be. They are so far off that we cannot study their surface. But there is one star near to us as compared with all others. This star we call the sun, and it is by studying it that we can form an idea as to what the others may be. The sun we know is a huge mass of flaming gases of the kinds of which the solid earth is made. This huge body moves round upon its axis at a very rapid rate, and has a series of bodies which move around it in certain fixed paths. These are the planets which we have spoken of as wanderers. Further there are smaller bodies or satellites which move around the planets. There are also other bodies called comets, about which little is known, and which revolve round the sun in such a way that at one time they are very near and at other times an immense distance from it.

The group of heavenly bodies having the sun as a centre is called the solar system. This consists of a huge central body of burning gases, so hot and bright as to supply the planets which revolve around it with light and heat, and so vast as to be greater in volume and mass than the united sizes of the bodies which move around it.

Just as the sun is a centre around which smaller bodies revolve, so some of the planets are attended by smaller bodies called moons. In addition to the planets and their moons there is a vast number of very small bodies which also revolve around the sun, and which when they come into our atmosphere appear visible as shooting-stars.

Now the sun is only one star among millions of others, many of which are doubtless far larger. Just as the sun is the centre of a system of cooling bodies, so may each fixed star be the centre of a system of its own. What a wondrous field does this open up to the imagination of myriads and myriads of other worlds than ours, no doubt habitable and who shall say not inhabited by man.

ce-les'-ti-al: belonging to the heavens.
com'-et: a word meaning the *hairy one*, so called from the long streaming tail.
lu'-min-ous: of a faint light.
sat'-el-lite: an attendant upon another.

56. THE SUN.

In the previous lesson we have seen that the sun is the centre of what we call the solar system. We have seen that the earth and the other planets revolve around him. While the planets are bodies which are slowly cooling and have a surface which is already hardened into a crust, the sun is a flaming mass throwing out sufficient heat to warm a body as large as our earth at a distance of over ninety millions of miles. And though the earth receives so much heat from the sun, it is so small that it takes but the smallest fraction of the sun's rays. So bright is the light which the sun throws upon the earth that when the face of the latter is turned towards him no other heavenly bodies are visible, and the sun's rays fill the whole heavens.

Size of the Sun.—The sun is really a huge globe, though like the moon it presents the appearance of a circular disc in the sky. Its diameter is about 860,000 miles, that is to say it is about 110 times as long as the diameter of the earth. The sun's volume is about 1,330,000 times that of the earth. These figures represent a size that the mind cannot possibly have a correct estimate of. Let us take a more familiar example to show the relative sizes of the sun and earth. If we take a three-inch globe and pick out Great Britain upon it, and then with a mere pin-point mark the town in which we live; this point made by the pin in the surface of the globe will bear the same proportion to the size of the globe which the earth does towards the sun. Further we have seen that the sun is the centre of a system of moving bodies, some of which are much larger than the earth. Now if all these bodies could be rolled into one they would not make a body nearly as large as the sun, which would outweigh such a body 780 times.

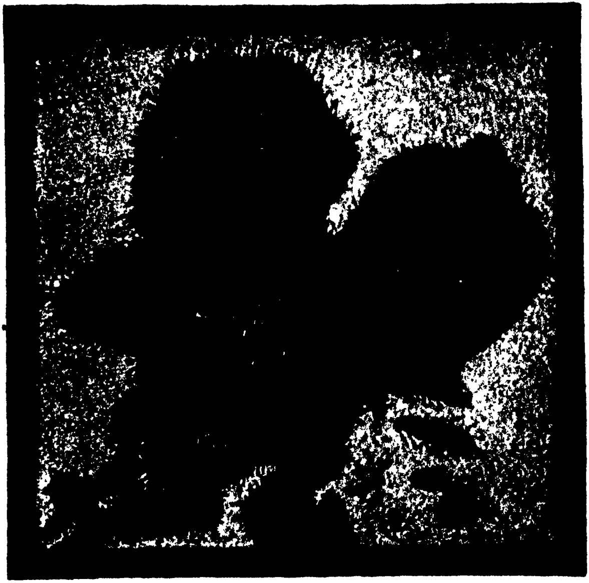
The mean distance of the earth from the sun is about 91½ millions of miles. The earth's orbit is of such a shape that the sun is three millions of miles nearer to the earth in our winter than in summer. Hence in winter the sun appears slightly larger than in summer, for the apparent size of an object depends upon its distance from the spectator.

Though the volume of the sun exceeds that of the earth more than a million times, its weight is only about 300,000 times that of the earth. This is owing to the difference in the density of the two bodies, and this again is due to the fact that the sun is a hot body while the earth is comparatively a cool one. In comparing the planets and their satellites, we are struck with the fact that the moon is now a cool body, though its surface presents all the appearance of having been hot. The earth is also a cool body in as far as its surface is concerned. But if we could penetrate into the interior of the earth we should find that the earth is still hot inside, though its surface is sufficiently cool to contain oceans and to support animal and vegetable life. Others of the planets, though they are cooling, are not nearly so cool as the earth, but are still enveloped by masses of hot gases.

Hence we see that the bodies which comprise the solar system are all cooling, though some are much cooler than others. The crust of the earth presents all the appearances of having passed through a period of intense heat, and its shape is that which a body would assume if it were launched forth into space a mass of glowing vapours which was slowly cooling while revolving rapidly upon its axis.

Sun-Spots.—When the sun is observed through a telescope, proper precautions such as the use of coloured glass to protect the eyes from the fierce rays having been taken, a remarkable phenomenon is often noticed. Instead of the face of the sun presenting a clear disc of intense light, it is often found to be marked with dark patches, which are called sun-spots. At times there is a large number of these spots; at other times there are only a few to be seen; while sometimes the face of the sun is quite free from them. The central portion of the spot is intensely dark, and it is surrounded by a margin which, though much darker than the general surface of the sun, is not nearly so dark as the centre of the spot. Some of these spots are of immense size, many thousands of miles in diameter; in fact some of them have a diameter greater than that of the earth. From careful observations of these spots astronomers have come to the conclusion that the sun rotates in much the same way that the earth does, only the sun takes about twenty-five of our days to make one revolution.

It is from the sun that the earth derives its light and heat. The daily revolution of the earth provides for alternate periods of work and rest, so that tired human nature has time to regain strength for renewed labours. The inclination of the earth's axis combined with its revolution round the sun causes the seasons, and thus provides vegetable life with periods for bringing forth fruit and for rest. We use the light and heat of the sun



SUN-SPOTS.

for all purposes. Our food, our clothing, the materials of which we build our homes, the metals of which we make our machinery, the steam-power which we employ to propel our ships across the ocean and to drive our locomotive engines on the land, the coal we use for fuel, all these owe their existence to the beneficent heat of the sun.

as-tro′-no-mers: men who study the heavenly bodies.	**re-vo-lu′-tion**: turning or moving completely round.

57. THE PLANETS. (I.)

The planets form a group of heavenly bodies of which we know much more than we do of the stars which are so much farther away. We have learned so much of the form and movements of the earth and of the various substances of which it is composed, that we have been able to bring this knowledge into use when studying the other planets. Each of the planets is a cooling body, and the coolest are the earth and Mars. Some of the others though they are cooling are still enveloped by volumes of hot gases.

The planets move in fixed orbits or paths around the sun. The orbits of all the planets take the form of an ellipse. This figure may be made by fastening two drawing pins in a board and then tying a piece of string so that it hangs loosely between the two points. If we now take a pencil and stretch the string slowly while moving the pencil against it on both sides of the two points, we shall describe an ellipse. This figure has really two centres or foci, and the nearer these are together the more like a circle the ellipse will be. In describing an ellipse in this way the looser the string is the more circular will be the figure. Now the orbit of a planet is a figure of this form, and the sun is situated in one of the foci.

The earth's orbit is such that when it is at its greatest distance from the sun, it is three millions of miles farther away than when it is at its least distance. The earth is near to the sun as compared with the planet Neptune, and while the former moves in a path which at its greatest distance is only 93 millions of miles away from the centre, the latter travels through an orbit which is 2,800 millions of miles from the sun. The planets are of different sizes, and are all in different stages of cooling. They move in orbits no two of which are exactly of the same form, though all the orbits are ellipses. They all take different times to perform their revolution round the sun, and no two have a day of the same length. But they have this in common, that they all belong to the same system, they all revolve around a common centre, and they all receive light and heat from the sun.

The planets which can be seen with the unaided eye are only five in number—namely, Mercury, Venus, Mars, Jupiter, and Saturn. Of the others Uranus may sometimes be seen as a very faint star, and Neptune is so far away as to be visible through a telescope only. Between the orbits of Mars and Jupiter there is a vast group of minor planets called asteroids. Of these about two hundred have already been discovered. The diameter of most of them is probably only a few miles. Though so small, they also revolve around the sun just as the planets do.

Mercury.—If we examine the planets in the order of their distance from the sun the first we shall notice is Mercury. It is much smaller than the earth, and has a diameter of about 3,000 miles. It appears in our sky sometimes as the evening and at other times as the morning star. This planet traverses the whole of its orbit in the brief period of eighty-eight days, so that if it has seasons similar to those of the earth, spring, summer, autumn, and winter will only be each about three weeks in length. Not only is its orbit much less than that of the earth, it is also of a very different shape, for though it is an ellipse, there is a much greater difference between the greatest and least distance of this planet from the sun. When nearest to the sun Mercury receives more than ten times as much heat and light as we do, but when he removes to his greatest distance, the light and heat he receives are only about five times as much. Even then, however, the sun blazes in the skies of Mercury with a disc four and a half times larger than that which he presents to the observer on earth. With all these differences we see that if there is vegetable and animal life upon this planet they must differ very markedly from those of the earth.

en-vel'-op-ed: surrounded or closed in by anything.

58. THE PLANETS. (II.)

Venus.—This planet also appears sometimes as an evening and sometimes as a morning star. It shines with a soft beautiful light, and is one of the best known of the heavenly bodies. It bears a striking resemblance to the earth in size, in the length of its seasons and its rotation, in the figure of its orbit, and in the amount of light and heat it receives from the sun. No other two planets present so many points of likeness as the earth and Venus.

It is about 66 millions of miles away from the sun, and when nearest to the earth it is only about 26½ millions of miles away. Its diameter is about 7,500 miles, and it takes 225 days to make a complete revolution round the sun. As far as is known Venus has no moon, neither does it need one. The chief use of the moon to the earth is to cause and regulate the tides. But Venus is so close to the sun that if there are oceans upon its surface, the tides, caused by the attraction of the sun, would be much higher than the tides upon the earth.

Mars.—This planet may often be distinguished from the other heavenly bodies by the red colour which it shows. Its diameter is only a little more than half that of the earth, and the surface of the latter is about two and a half times as large. Its mass is so much less than that of the earth that the force of gravity at its surface is so small that a body which would weigh a pound on the earth would weigh only 6 oz. 8 dwts. upon the surface of Mars. A man could therefore jump higher and run faster than on the earth, for the force of gravity which pulls towards the centre of a body would be so much less. A year, that is the time required to make a complete revolution round the sun, is 687 of our days, and a day is about forty minutes longer than ours.

Owing to the figure of its orbit Mars sometimes approaches to within forty millions of miles of the earth, and so astronomers have been able to examine its surface more thoroughly than that of the other planets. They have found that Mars has two small moons, and that around the poles there are icy regions just as there are upon the earth. They have also noticed large dark patches which they take to be water, and other copper-coloured masses which they say are land. They have

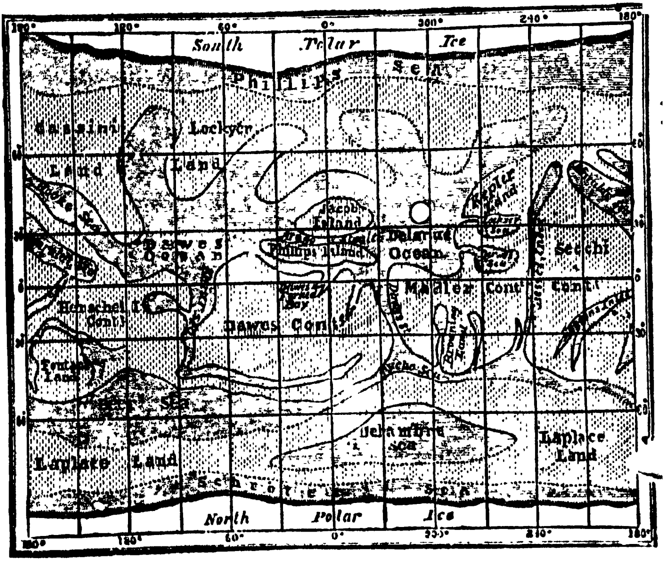
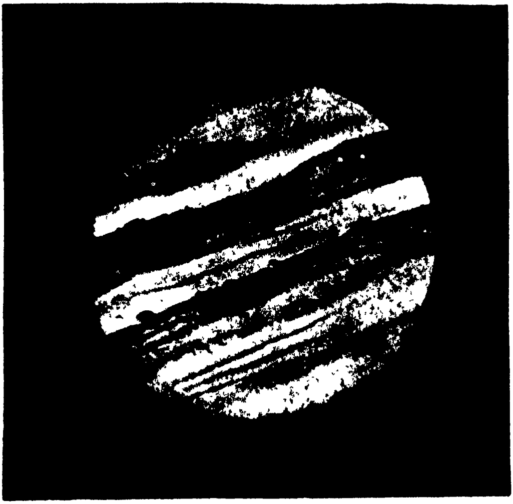


CHART OF MARS.

even prepared maps showing the oceans and continents. From various changes in colour on its surface they have come to the conclusion that there is a rich vegetation. This we know could not exist without rainfall, and from other observations they say that Mars is enveloped at times in clouds, and that it has winds and rain just as we have upon the earth. Hence we see that Mars is also fitted for the habitation of human beings.

Jupiter.—This planet is the giant of the solar system. It has a diameter of about 85,000 miles, or nearly eleven times that of the earth, and a surface 115 times as great. Exceeding our earth some 1230 times in volume and more than 300 times in mass, this magnificent orb is the crowning proof of the relative insignificance of the earth in the solar system. Jupiter rotates upon his axis in rather less than ten hours, and therefore moves at a fearful rate, but he requires more than 4,000 of our days to complete his journey round the sun. His orbit is at the enormous distance of about 476 millions of miles

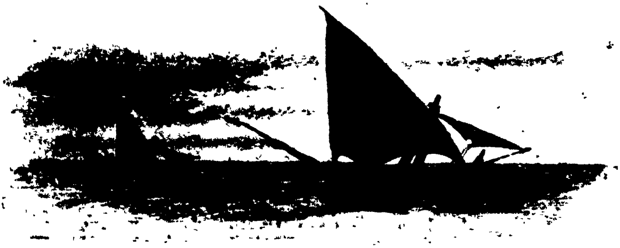


THE PLANET JUPITER.

away from the sun, and he is therefore far from our earth. But owing to his vast size he shines brightly in our heavens, sometimes as an evening star, sometimes throughout the night, and at other times as a bright morning star. When the earth reaches such a position in its orbit that Jupiter is on the side of the sun away from the earth he is no longer visible to the unaided eye but by the aid of a telescope can be seen in full daylight. Jupiter has four moons, two of which are about the same size as the planet Mars.

But the most wonderful feature in studying the surface of Jupiter is that of its belts, which are broad bands parallel to the equator. Some are of a pale-blue colour, others are crimson. These belts are largely, if not wholly, formed of rolling clouds, drifting and changing under our eyes. From all that we know of this planet it is probably in the same state that our earth was in millions of years ago before it had become cool enough to be inhabited by man.

gra'-vi-ty: the force which pulls everything upon the earth's surface towards its centre.	**orb**: a globe.



59. THE PLANETS. (III.)

Saturn.[1]—In all the heavens there is no more wonderful object than Saturn. This planet is a globe nearly 70,000 miles in diameter, and its outermost ring is over 150,000 miles across. The belts on the globe show delicate tints of brown and blue, and parts of the ring are, as a whole, brighter than the planet. But this ring, as may be seen by referring to the illustration, consists of at least three main divisions, each itself containing separate features. First is the gray outer ring, then the middle one, and next the curious 'crape' ring, very much darker than the others, looking like a belt where it crosses the planet, and apparently feebly transparent, for the outline of the globe has been indistinctly seen through it. The whole system of rings is amazingly thin, and when it is turned edgewise to us it disappears to all but the most powerful telescopes, in which it looks like the thinnest conceivable line of light. Another wonderful feature of the ring is that it rotates with a smooth and steady motion around the globe of the planet. For a long time this ring was a puzzle to the astronomer, but now it is generally believed that it consists of a multitude of bodies so small that in the vast distance they seem to be a luminous band of light. Not only has Saturn its mighty rings, but he is also attended by eight moons, one of which is even larger than the planet Mercury.

In volume and mass Saturn is about seven hundred times the size of the earth. He occupies about 29½ of our years in making one revolution round the sun at a distance nearly twice as far from it as Jupiter, and nearly ten times as far from it as the earth. But though he is of such an immense size he revolves very quickly, and takes only 10¼ of our hours to complete his day.

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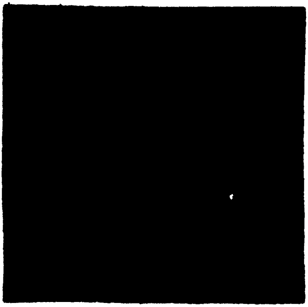
[1] See Frontispiece.

Uranus and Neptune.—The first of these planets describes an orbit which is nine hundred millions of miles outside the orbit of Saturn. At about the same distance beyond Uranus, the outermost of the planets—the mighty Neptune—circles round the sun. These two planets resemble each other in size, and are both of them much smaller than the two giants Jupiter and Saturn. Uranus has a diameter of about 33,250 miles, and Neptune is somewhat larger, his diameter having been estimated at about 37,250 miles. Both planets exceed Saturn in density, but when we compare them with the earth we find that their density is only about equal to that of water. They are so far away from the sun that he only appears to them as a bright day-star, and the heat and light they receive from him are correspondingly small. Uranus is attended by four moons, but as far as is yet known Neptune has but one. While Uranus takes about 84 years, Neptune takes 165 years to complete a revolution about the sun.

Comets.—Besides the planets, there are certain other bodies belonging to the Solar System which are sometimes seen moving among the stars. These bodies are called comets. A comet usually consists of a more or less brilliant point or nucleus surrounded with a mass of nebulous matter, which is often extended in one direction so as to form a tail. A comet is only visible in the heavens for a limited period. It first appears in some region of the heavens where nothing of the kind had been seen a few days previously. From day to day the comet changes its position and its brightness, and even its shape. It will remain visible for some weeks, or perhaps months. Occasionally it becomes lost to view from having gone too close to the sun, and then again the comet is seen on the other side of the sun, when, after remaining visible for some time, it gradually recedes, becomes fainter, and is finally lost to sight. A comet travels in an orbit which is of such a shape that whereas at one time it is near the sun and is then visible at the earth's surface, at another time it may be an immense distance away.



A COMET.

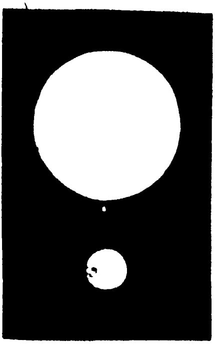
Meteors.—Under this name are included all those small bodies which reach the earth's atmosphere from without. Some of them fall unbroken to the earth's surface as aërolites; others explode into small fragments, as fireballs have been seen to do; while others are apparently consumed in traversing the upper regions of the air, as happens with shooting or falling stars. All these objects are in reality bodies of greater or less size which, before they came in contact with the earth's atmosphere, were moving in their course round the sun.

nu'-cle-us: the central mass around which matter gathers.
re-cedes': moves farther away.
trans-par'-ent: that can be seen through.
tra'-vers-ing: passing across.

60. THE MOON.

JUST as the earth and the other planets revolve in their orbits round the sun, so does the moon revolve in her orbit round the earth. Being so much smaller than the earth, the moon is held in her place by the attraction of the larger body. She shines by means of the light thrown upon her by the sun, and this is reflected upon the earth The moon's diameter is only 2,159 miles, and her volume is only about one-fiftieth of that of the earth, while the earth's mass is 81½ times that of the moon.

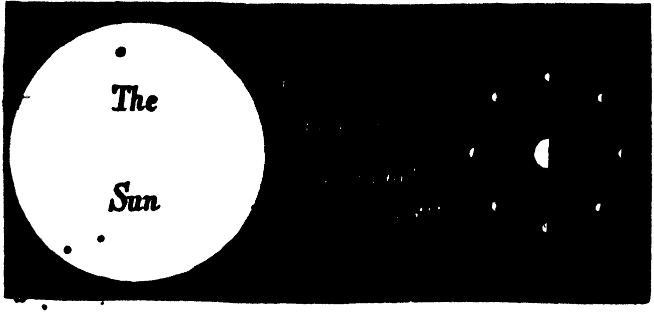
She travels round the earth at a distance of about 240,000 miles, and takes 27 days 7 hours 43 minutes to complete a revolution. The moon is a cool body, much cooler than the earth. Not only has the crust become cold, but there is probably very little heat in the interior. Hence the atmosphere has vanished, the oceans have disappeared, the volcanoes are extinct, and the surface of the moon acts as a huge reflector throwing the rays of the sun upon the earth.



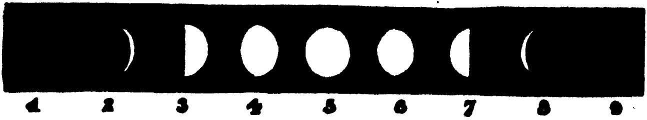
RELATIVE SIZES OF EARTH AND MOON.

Phases of the Moon.—The sun always presents to us a complete circular disc. The moon, on the contrary, only shows us a complete circular disc for a few hours in each revolution. In the period during which she completes the circuit of the heavens she presents to us every possible gradation between a circular disc perfectly illuminated and perfectly dark.

Let us select some evening in which, just after the sun has set, the moon is seen low down in the west. The moon then appears to us in the form of a narrow crescent as in fig. 2, and we call it **new moon.** From day to day the crescent enlarges and the moon sets later, till on the seventh day it appears like a semicircle as in fig. 3, and



is visible during the greater part of the night. This period is called the first quarter. For the next seven days the luminous portion continues to increase until on



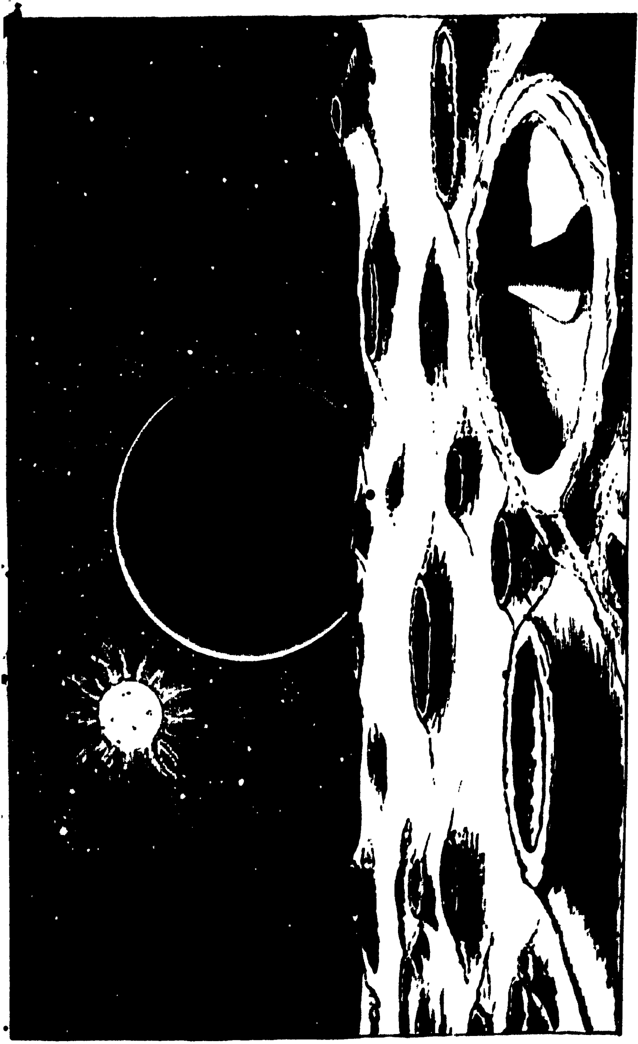
the fourteenth or fifteenth day the disc of the moon is entirely luminous as in fig. 5, and now it is said that we have full moon. On the following day the western edge of the moon is seen to be somewhat less sharply defined. Gradually this part becomes more and more obscured, until on the twenty-second day the moon is again a semicircle as shown in fig. 7. This period, during which the moon wanes from full to half-moon, is called the last quarter. About the twenty-eighth day the moon has drawn very near to a position between the earth and the sun, after which she becomes invisible for a few days, again to reappear in the form of a narrow crescent and to repeat the cycle already described.

It has already been said that the moon takes 27 days 7 hours 43 minutes to travel round the earth, and it is a curious fact that she takes the same time to rotate upon her axis. During the entire revolution the illuminated portion is always turned towards the sun, and the dark part is turned away from the sun. Hence it follows that we always see the same face of the moon.

We have seen that the moon has two motions, a revolution upon her axis and a revolution round the earth. But she has also a third motion, for she is carried forward by the earth as the latter journeys round the sun. While the moon is making its revolution, the earth has moved onward in its orbit, and so the moon requires 29½ days to regain the same position towards the earth and the sun.

The Moon's Surface.—The surface of the moon is very rugged and irregular, and while there are some regions which appear comparatively level, there are others where mountain ranges and chasms give an appearance of rugged grandeur to which we have no parallel on the face of the earth, though in comparing the earth and moon we must remember that whereas there are no oceans on the face of the latter, the deepest hollows in the earth's surface are filled with water.

But the most characteristic objects on the surface of

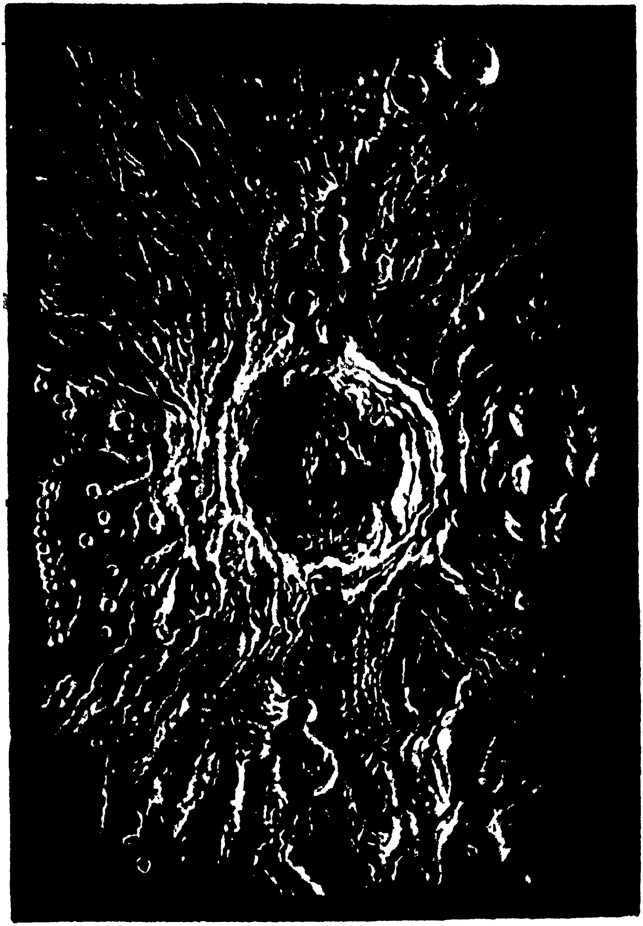


EARTH AND SUN AS SEEN FROM THE MOON'S SURFACE.

the moon are what appear to be the craters of volcanoes, which, though once active, are now nearly, if not quite, extinct. There are some hundreds of these objects on that face of the moon which is turned towards us, and many of them are of truly colossal dimensions. One of the grandest of these craters measures fifty-six miles across it. Like most of the other craters it is enclosed by a ring composed not only of terraces, but also of distinct heights separated by ravines. The summit of the ring is a narrow ridge not quite circular in shape, and rises over 11,000 feet from the bottom. From about the centre of the crater there rises a mountain of considerable height. In this as in other craters a succession of eruptions may be traced in the repeated encroachment of rings upon each other, where the materials thrown out from the interior seem to have been disturbed before they had time to harden.

Present Condition of the Moon.—The moon presents all the appearances of having gone through all the cooling stages through which the planets are now passing, but owing to the smallness of its size it has cooled more rapidly, and may possibly present to us a likeness of the condition our earth may reach in the course of future ages.

Supposing the moon to have been at one time a hot body, and to have been gradually cooling, then the volcanic appearance of its surface may be explained. If the moon has gone through the same stages as the planets, then we must suppose that at one time she was surrounded by an atmosphere, and that oceans rolled upon her surface. Now we know that at present the moon is



THE LUNAR CRATER COPERNICUS.

airless and without water. If we examine a baked apple when it is first taken out of the fire, we shall see that the skin is stretched tightly and smoothly over it. As it cools the skin gradually becomes wrinkled and cracked. The surface of the moon presents a somewhat similar appearance, and seems as if in the process of cooling and shrinking, earthquakes rent its surface in mighty rifts and chasms, and volcanoes burst forth in all directions. The waters on its surface would gradually fall through the openings in the surface to the interior, thus causing the large volcanoes whose extinct craters now form the most wonderful feature of the surface of the moon.

col-oss′-al: of huge size.
cres′-cent: the shape of the moon as she increases towards half-moon.
ra-vine′: a long deep cleft in the mountains.
re-flect′-or: a surface which reflects or throws back the light.